Municipal and County Engineering

DESIGN, CONSTRUCTION, OPERATION AND MAINTENANCE OF ALL PUBLIC WORKS

Vol. LXVII. OCTOBER, 1924 No. 4

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"RAILWAY AGE" DISCUSSES BUS AND RAIL COMPETITION

(Editor's Note: We quote herewith an editorial entitled: "Competition of Motor Buses with Railroads," published in the *Railway Age* of Aug. 30, 1924. The *Railway Age* is the most successful, most influential, and most authoritative journal in the railway field. On questions of broad policy it generally reflects very accurately the thoughts of the really big men in the railway field. It is very important that the public and press of America should realize what the big railway men are thinking on this subject. Many local railway men do not seem to be keeping up fully abreast with their own leaders of thought. Probably this is due to the fact that the average railway man's vision does not extend beyond his immediate responsibilities. He does his daily task with little thought beyond the work of the department to which he is assigned. Even the larger affairs of his own road interest him but slightly. Of affairs affecting the railway business as a whole he knows little and cares less. His chief concern is to see to it that some other department doesn't "get something on him or his department." The editor of *Municipal and County Engineering* is speaking from experience and close acquaintanceship with railway men. As a civil engineer he has worked for three different railway companies and he worked for one of them at three widely separated periods. He had one job running a location survey for a rail line through the swamps and pine woods of Florida and Alabama. Not a man in the party knew who we were working for. It is "a wise railway man who knows his own father," so to speak. It will be remembered that even the children of the immortal Casey Jones "had another papa on the Salt Lake Line." The point we wish to convey is that the railway "children" are not always posted on what the railway "papas" are thinking about. But we are detaining the reader. Let us proceed with the quotation from the *Railway Age*.)

"The recent rapid development in the transportation of freight and passengers in motor buses over the public highways cannot be ignored by the railroads. Although still in its infancy, highway transportation has removed all doubt that it will eventually take an important place in our national transportation system. It has justified its existence by the services it can render better and more cheaply than the railroads. A considerable volume of traffic now carried as a matter of course by the railroads will sooner or later find its way to the motor buses. Thus the buses' gain will be the railroads' loss and the loss will be too large to be overlooked.

"A number of roads are now endeavoring in one way or another to protect themselves from this growing bus competition. Most of these attempts have been defensive moves, and as such are headed for failure, for battles are not won by defensive tactics. This has been recognized by the Chicago, North Shore & Milwaukee, an electric line operating between Chicago and Milwaukee, Wis. An article in the *Railway Age* of August 16 described the aggressive way in which this road has handled the bus problem. Two years ago a number of bus companies were preparing to start operating in its territory. Ifmmediately the railroad purchased a fleet of buses, opened up routes where they were needed, and began the intensive use of buses as feeders to its main line. The service offered was superior to that which smaller bus operators could provide. The result is that there are no competitive buses in North Shore Line territory today.

"Railroads all over the country are finding motor bus competition a problem. It will be a much more pressing problem as time extends and intensifies the operation of the buses. The motor bus and the motor truck are here to stay. The railroads must recognize this fact, and they must determine on their methods of meeting this competition without delay. Like the North Shore Line, the railroads with their established stations, their reputation for regular service and their resources, are in an advantageous position. They can eliminate much bus competition, as the North Shore Line has done, if they will. The recent announcement of the Omnibus Corporation of America that it has a plan for contracting with railroads to establish motor bus feeder lines should be interesting to every railroad.

"Competition from new sources is inevitable in the future. The days when the railroads afforded the only kind of transportation are over. Already we have the motor bus. Tomorrow the airplane will be in the fight for traffic. Disregard of the new developments in the

field of transportation will be disastrous to any railroad."

RECENT DEVELOPMENTS WITH THE ACTIVATED SLUDGE PROCESS

(Editor's Note: Following is the full text of the report of the sub-Committee on Sewage Disposal of the American Society for Municipal Improvements. The members of the Committee are Langdon Pearse, Chairman; T. Chalkley Hatton and J. C. McVea.)

The sub-Committee on Sewage Disposal this year has only a very brief report to make, in that the work started last year is not yet completed in the testing of the value of activated sludge and other sludge for fertilizer.

In the execution of this work the Milwaukee Sewerage Commission, Mr. T. Chalkley Hatton, Chief Engineer, and the Sanitary District of Chicago, Mr. E. J. Kelly, Chief Engineer, have been cooperating in extended studies of the applicability of this material to the problem of growing sod and grass for use in golf ground construction and maintenance, as well as in the use of the material in truck gardening and floriculture.

In this a great deal of experimenting has been done in the various experimental farm plots of the State of Wisconsin, as well as in the two acre farm maintained and operated by the Sanitary District of Chicago at the Calumet Sewage Treatment Works. A full size test is being made in a rose house at Batavia, and also on carnation growing. Experience is also being gained in practical truck farming on celery, onions, sugar beets and other crops requiring nitrogen. The results to date are very encouraging as to the availability and value of the material for use in growing grass, plants and vegetables requiring nitrogen. A considerable demand for retail packages of 100 lbs. or less has also grown up for use on city house lots and in parkway maintenance. The current price of the sludge is $22 per ton f. o. b. cars Maywood, Ill.

The outstanding developments this year in the field of sludge disposal from the activated sludge process seem to be largely in the abandonment of the Maclachlan process at Pasadena, the continued production by the Oliver type of press, the type of filter in use at the Calumet Sewage Treatment Works of the Sanitary District of Chicago, and in the development of a simple hydraulic direct squeeze bag press by Berrigan at the Des Plaines River Sewage Treatment Works of the Sanitary District of Chicago. Certain improvements and type in bag construction and drainage are still being made on the latter press, so that the final comparative results are not yet available.

With the opening of the Indianapolis plant this fall, and the additional production from the Milwaukee plant next summer, the sludge production of the Central West will be very much increased. There appears, however, to be a legitimate opening for the use of this material put on the market in shape to pass through an 8 mesh sieve with No. 18 wire.

BUSES REDUCE TROLLEY COSTS

Adoption of motor buses by electric railways will do more than any other measure to stabilize the trolley business and earn the good will of the public, in the opinion of A. J. Brosseau, a director of the National Automobile Chamber of Commerce, speaking before the American Electric Railway Association Convention in Atlantic City, on October 9, 1924.

Citing experiences of the United Electric Railways, Providence, the Pennsylvania-Ohio Electric Co., and elsewhere, the speaker outlined six profitable uses of the motor bus as linked with electric operation:

1. In thin traffic regions, where business does not warrant investment in railway equipment.
2. In heavy traffic areas to handle local passengers.
3. In light traffic hours when costs of power station operation can be saved.
4. In developing new territory, as feeders to rail routes.
5. In city transportation, to meet public demand for bus service.
6. In inter-urban transportation, to meet public demand for bus service.

"What I have in mind," said Mr. Brosseau, "is the use of *each* form of transportation in its place and in the way which best suits the public's convenience and necessity.

"There is a place for both types of vehicles, and if they are properly coordinated the result will be to the advantage of the transportation company, the rider, and the public."

RESULTS OF IMPROVING THE SUB-GRADE FOR PAVEMENT FOUNDATIONS

By Clarence D. Pollock, Consulting Engineer, Park Row Bldg., New York, N. Y.

Much more attention has been given to sub-grade conditions recently than was formerly done. The importance of this question is becoming more and more evident and much thought is being given it. The United States Bureau of Public Roads has been and is now carrying on tests, the results of which will be of great assistance to engineers having to do with the designing and constructing of pavements. Others also are devoting a great deal of attention to this matter and the result is that much data is being obtained from which at least some general conclusions may be drawn.

Granular Sub-Soils

When the sub-soil consists of sand or other good granular and porous material, it has been found that a foundation 6 ins. in depth of the standard 1:3:6 mixture of Portland cement-concrete is ample to place under pavements to carry modern traffic; but the question is what is to be done when the soil consists of clay or other material which may become plastic and will not afford sufficient support for the foundation during at least part of the year? Placing a greater depth of concrete will help in spreading the load over a greater area of the soil, but it is expensive and if the soil is one which has a considerable volume increase with the increase of its water content, this will not materially help matters as the swelling of the soil will heave the heavier concrete about as readily as it will the lighter.

Removing Part of Sub-Soil

If instead of using a greater depth of concrete under such conditions a layer of the clay or plastic material be removed and replaced by a granular and porous material such as sand, gravel, or steam cinders, and the concrete foundation placed upon this material, it has been found that the sub-soil does not swell and lift the pavement. This granular layer not only provides drainage, but distributes the load over a larger area, similar to the ballast under railroad ties, also it decreases the friction on the under side of the concrete and thus helps in preventing the formation of cracks. It has been found that with clay against the under side of the concrete that with even very small differences in temperature between it and the concrete there is a condensation of moisture on the under side of the concrete which in cold weather freezes and thus adds to the volume increase and consequent heaving of the pavement. With the porous layer between the foundation and the clay sub-soil there is no condensation on the bottom of the concrete and thus this trouble is avoided.

Moisture Content of Sub-Grade Clay

Other methods have been tried for improving the clay sub-soils such as in the case of the Bates Test Road in Illinois. It has been pretty well demonstrated that the bearing value of most clay soils is greatly affected by their moisture content. In connection with the Bates Road Tests attempts were made to control the moisture content of the sub-grade clay. Under each edge of one section a tile drain was laid 24 ins. below the sub-grade, the trench was backfilled with cinders and free outlets were provided for the drains. During a period of three years the moisture content of the sub-soil of this section was observed and compared with that of adjacent sections without such drains, but no measurable difference in the moisture content of the sub-grade was found. In another longer section on the Chatham Road having a different character of clay a similar test was made, except that the drains were placed at a depth of 42 ins. below the sub-grade at each edge of the pavement. Here a greater amount of moisture was found at all times in the soil with the drains than in that of the adjacent sections without drains. No attempt was made to explain this, but it at least showed that the drains did not improve conditions. Tests were made by reversing the process in the case of each of these roads by attempting further to saturate the clay under them, but this was also unsuccessful. It was found that with the normal summer saturation these clays resisted further saturation. In other words, the attempt to control the moisture content of these clays by means of tile drains was a failure. Other experiments indicated that if the moisture content of these clays was reduced to a point where they were dry enough to crumble readily, absorption took place rapidly until they reached the point of saturation and then absorption stopped. These tests showed that clays with their normal moisture content resisted both an increase and a decrease of moisture.

Mixed Soils

Between the sands and the clays there

are many soils which are mixtures. Which of these will properly support a pavement and which will require a porous layer under the pavement foundation? The Bureau of Public Roads is now investigating this side of the problem. Because of the many kinds of clays in the soils and their different effects it is probable that no very definite rules may result, but some general conclusions may be drawn such as that a soil high in clay and high in water absorption will usually have a high volume change and consequently require the placing of agranular layer at the sub-grade. The judgment of the engineer from his experience must play an important part in deciding where to draw the line, however. Naturally there are many cases of streets and roads where the clay will be found only here and there in pockets and it will be necessary to place the porous layer at these points only. Other cases will occur where it may be more economical and serve the purpose as well to add a small amount of sand to the soil and plow or otherwise work it into the sub-grade in order to make it sufficiently porous.

Thickness of Granular Layer.

Studies are now being made to determine the proper thickness of the granular layer when it is required. The writer has obtained good results by the use of 5 ins. and even with 4 ins., and understands that others report excellent results with some clays by using a thickness of 3 ins. of graular material.* In tests with some clays and a careful placing of the sand layer, a 2-in. depth has proven successful, but it would seem better to use a greater thickness than 2 ins. because of the difficulty of obtaining sufficient uniformity of depth in actual construction.

Thinner Pavement Bases

Another advantage of a greater depth of the granular layer is that this layer will distribute the loads better on the sub-soil. Tests tend to show that it may be possible to decrease the thickness of concrete foundations below the standard 6 ins. in many cases by the use of a porous layer, because of this feature of its distributing the load over a greater area of sub-soil. More tests along this line are desirable, and some are being made.

If further results confirm those previously obtained, there should be much valuable data available from which to make deductions as to what extent the depth of concrete foundations may be reduced in many cases, and also as to the use of other and less expensive forms of foundations under certain conditions such as in highways and streets in many of the smaller cities and towns.

It is probable that it will be desirable to continue the use of concrete foundations 6 ins. in depth in the larger and faster growing cities, because with the frequent openings due to the constant changes in the structures along the streets in such places, the bridging effect is valuable, if the backfill in trenches settles, as it is likely to do in many cases; but in other places where few openings may be looked for, it is probable that a considerable saving may be made on the foundation so that a better and more durable pavement surface may be afforded.

The writer has laid a large amount of granite block pavement on a 5-in. cement concrete foundation on sandy and gravel sub-soils without foundation failures as well as many miles of asphalt similarly without foundation troubles; likewise he has had excellent results from a rolled broken stone base over a similar sub-soil when the location was such that it was not subjected to trench openings, and was paved with granite blocks subjected to heavy truck traffic.

More Thought Should Be Given Pavement Foundations

So many millions of dollars are being spent on highway and street pavements each year that it would seem as though as much thought should be given to the soil and foundation conditions of pavements as is given to these features in connection with buildings. The soil condition should be studied and if it is not of a suitable character to support the pavement properly and its traffic during all seasons of the year, it should be corrected so that it will do so.

We have been so keen for standardization in recent years that we have probably overdone it in the matter of using a standard of 6 ins. depth of foundation in many cases where a less depth would have been sufficient. The standardizing should have been below the foundation and the soil standardized instead, by bringing the soils of poor supporting value up to proper standards. In this way much money might be saved and the saving devoted to constructing more miles of pavement or to more durable forms. We should all be interested in this question of improving the sub-grade for pavement foundations whether we are

engineers, contractors, material men or just taxpayers, as it will benefit every one of us.

The foregoing paper by Mr. Pollock was presented at the recent annual meeting of the American Society for Municipal Improvements.

CONSTRUCTION OF ASPHALT-FILLED GRANITE BLOCK PAVEMENT AT ELIZABETH, N. J.

By Thomas E. Collins, City Engineer, Elizabeth, N. J.

Elizabeth, New Jersey, a city of 110,000 inhabitants, is in the metropolitan district of New York located on the Lincoln Highway between New York City and Philadelphia. Because of its location, the main arteries in the city are subjected to very heavy traffic. Realizing this condition, we have adopted granite block as a standard for heavy traffic streets.

Concrete Foundation

The concrete base for this class of pavement is 6 ins. thick and is composed of 1 part Portland cement, 3 parts sand and 6 parts trap rock.

In order to facilitate the work, it was found advantageous to store materials used in the concrete base at street intersections. The materials are loaded by automatic machinery into 1-ton Ford trucks and by this means are transported and dumped directly into the hopper of the concrete mixer.

Cushion

The cushion between the concrete base and the granite block pavement is composed of a mixture of 1 part of Portland cement and 3 parts of sand.

Granite Block

Granite blocks are obtained from the quarries in New England. They are shipped from there on barges to our municipal dock located on Staten Island Sound. Upon their arrival, the lighter transfers the blocks from the barge to motor trucks, which haul them to the job and dump them directly on the concrete base. This method eliminates the necessity and inconvenience of piling them along the sidewalks and consequently reduces the cost of paving.

Asphalt Filler

Previous to the year 1923, it was the practice to use cement grout filler for the joints. We found, upon investigation, however, that better results could be obtained by using an asphalt filler and hence have adopted this as our standard.

During the year 1923, 32,000 sq. yds. of this class of pavement were laid in this city and at that time the asphalt was delivered in barrels. This necessitated the hauling of the asphalt from the plant, removing the barrels on the job and then cutting the filler into sizes that could be easily lifted into the storage tanks on the work. We found this method not only inefficient but very costly. For that reason we have adopted the scheme of delivering the asphalt in auto tank trucks on the work.

The asphalt filler for granite block pavement is refined from liquid crude asphalt through the process of distillation until the material has been brought to the proper consistency. It is then pumped into storage stills where it is maintained at a temperature varying from 350 to 375 deg. F. From the storage still, the asphalt filler is pumped through a 4-in. line to auto tank trucks at a temperature varying from 350 to 375 reg. F. The material is transported in trucks to distances up to 25 miles at these temperatures, and it is pumped from the tank trucks to kettles on the work when it is then ready for the mixture of sand without any pre-heating. The tank trucks used for transporting the asphalt filler have a capacity of 1,000 gals. and are insulated to maintain heat of the product while in transit. They are also equipped with air compressors for discharging the material to the contractors' kettles. A quanity of 1,000 gals. is discharged in about 20 minutes.

Removing Excess Filler From Surface

A very important part of this work is to see that all the excess asphalt material is removed from the surface of the blocks, which is accomplished by heating irons in a wagon containing burners. This method is a great improvement over the old method of heating the irons in woodburning kettles, as it heats them twice as fast.

It is quite necessary to have a sufficient number of men with hot irons so that the material can be pushed into the joints quickly and the excess removed from the top. We found during the year 1923 that on one street, due to lack of sufficient hot irons, a greater amount of asphalt filler than necessary was left on the surface of the blocks. This excess became very annoying to the business men on the street and it was found necessary to devise some method of removing it. After giving the subject careful consideration, we adopted a scheme of heating the excess material by burners and removing it with hot irons. This proved to be very

efficient and I can recommend it as a practical and economical method.

Asphalt Filler Recommended

After supervising the construction of many thousand yards of granite block pavement with cement grout and asphalt filler, I would recommend the use of asphalt filler for the following reasons:

(1) It is the most practical and economical pavement for heavy traffic streets, especially in large cities in the metropolitan district.

(2) It eliminates noise, which is very objectionable to business houses and residents.

(3) Repairs can be more easily and quickly made to openings that are made necessary.

(4) When the paving work has been completed it is possible to open the street for traffic within a few hours, while with grout filler the street must be closed for at least five days.

The foregoing paper by Mr. Collins was presented before the recent annual meeting of the American Society for Municipal Improvements.

ASPHALT SURFACING OF OLD MACADAM AND GRAVEL IN OHIO

By H. S. Perry, Assistant Chief Engineer, Bureau of Maintenance, Ohio Department of Highways, Columbus, Ohio.

In Ohio there are 83,500 miles of roads: of this 10,500 are on State System, of which about two-thirds are under State supervision, 2,200 being macadam in conditions ranging from fair to excellent, and 500 being gravel. The other one-third of the State System is still under county control and includes about 800 miles of macadam, largely traffic-bound, and about 1,000 miles of gravel. A great many of the miles of the State System are old and many are too narrow to meet present day needs. Ohio, therefore, presents a fertile field for the development of the subject in hand. The writer will endeavor to enlighten you regarding sections previously constructed, our present program, and future possibilities, as well as to discuss several types of the asphalt family in use outside Ohio; and typical cross sections.

Local Conditions

The southwest quarter of Ohio possesses an abundant supply of excellent road building gravel, which has been used extensively in highway construction. I would estimate that there are, in this territory, 1,000 miles of good county gravel roads in a condition closely approximating the desired. The northwestern third of the State is very well supplied with good limestone quarries being operated by some 75 producers, the capacity of some of which runs as high as 250 cars per day. There are probably 2,000 miles of good county macadam in this territory awaiting a better top. The northwestern quarter and the extreme southern part furnish slag, which is used in large quantities in macadam construction. Perhaps 3,000 miles of slag macadam exists in this territory on county and State roads and should present a fertile field for surfacing. The less populated southeastern portion of the State has for its typical type of construction macadam on sandstone, all local material and of varying quality, and a large mileage of gravel along the Ohio River.

Resurfaced Gravel

On two of the State roads leading north out of Hamilton, Ohio, we have about nine miles of gravel resurfaced with sheet asphalt 1½ in. with binder edging. This gravel road was of substantial construction by the county and had been built up gradually under maintenance over a period of years. The sections are two and five years old and are standing up very well. The edges on the five-year-old section gave us some trouble during the past summer and required a replacement of about 10 sq. yds., all due to base failure. The chief source of trouble with this type undoubtedly arises from base weakness. The trouble would have been avoided in this case, if the width of the pavement had been slightly less. Failures on this type due to weak bases are cumulative and should be guarded against by having a wide overhang on the base to provide both vertical support and a resistance to lateral yielding. No special preparation of the old gravel road was required further than to vary the thickness of the binder in order to produce a uniform crown. The gravel road was swept as clean as possible and to date there is no evidence of creeping or rutting; the surface is in excellent condition. Gravel and traffic bound roads are usually apt to be thin at the edges; it therefore is very essential that a careful study of thickness be made before the width of the surface should be decided upon. This should be a deciding factor in adapting this type to a route that is sure to be

subjected to very heavy truck traffic; for heavy slow moving vehicles generally drive near the edge and are quick to expose any weak places in the base.

Emulsified Asphalt and Amiesite

There are two other tops with which the writer is familiar and which seem very satisfactory; namely, asphalt emulsion and amiesite. South of Indianapolis I observed a section of the former, laid about 1919 and on an old gravel road and in excellent condition in 1923. I believe this was a 2 in. course. There were no breaks at the edges, evidencing a cohesion similar in value to the hot tops and showing that the effective bearing width of the base was not overestimated. I believe that amiesite is another cold mix which, laid 1½ in. and ½ in., would make a very practical top for a gravel or macadam base. Several weeks ago the writer observed some twelve-year-old amiesite in central Pennsylvania standing up remarkably well. It was on a traffic bound base and stood up perfectly under a heavy traffic during the war, being on one of the main routes.

The use of the one course types are not generally so well adapted to resurfacing gravel roads, as the two course, because of the variable cross section, which a binder course can make more uniform at a cost much lower than would obtain by varying the thickness of a one course sheet. All are subject, of course, to the basic principle that this type of top, and all others, must be well supported. Let us all remember that native gravel is usually cheap and use plenty of it. To place an elegant asphalt top on an inadequately constructed gravel base would be about as sensible as to attend a dress function in overalls and high hat. Before leaving gravel resurfacing, I should make note of the fact that the Ohio Highway Department made its initial investment during 1924 in surface treated gravel. About 35 miles were treated, largely to relieve traffic of the dust nuisance. The work is holding up very well, but will undoubtedly require annual attention of a similar nature to the extent of approximately one thousand dollars per mile. No definite plans have been formulated for the future expansion of this work, but it is highly probable that more of it will be done.

Salvaging Old Macadam

We have done considerable work on our State System in Ohio in salvaging old macadam. About 100 miles of this has asphaltic top. We have used sheet asphalt, asphaltic concrete, and Kentucky Rock asphalt over old macadam. It is not my purpose to make this article burdensome by going into minute detail, but to give some of the important points in construction, as they have come to our attention. I will cite a few samples.

During 1919 the State repaired an old macadam road in the north central part of the State by adding a thin leveling up course the same width as the base (16 ft.). At the time no plans had been made for any additional course, and no special attention was given the job, furthan than to secure a good riding surface and a well-bonded top. On about four miles of this a contract was later sold for a 2 in. topeka top 16 ft. wide, it having appeared that the somewhat soft stone might not weather well. This type of course should not generally be promoted, in my opinion, because of the many other superior asphalt surfaces; but I want merely to call to your attention one item. The writer appeared on this job when about one-third completed and noticed the forms set on one side about 2 in. outside the edge of the macadam. On questioning the inspector, I learned from him that he had to do it to get his width. I learned that he had forced the contractor to do this at other points and of course I immediately changed the side forms. It was quite natural to have expected minor variations in the width of a road, or in its alignment, but no asphaltic top should be expected to stand up on dirt. Today it is very easy to go over this section and pick out the places where the topeka is unsupported. A top of this kind should never be placed, as I see it, on a base of this kind without considerable overhang.

Proper and Improper Uses of Rock Asphalt

On a nearby section of the same road a rock asphalt job was sold. This has since proved itself, as per my own prediction, the best illustration in the State of how and where not to lay this material. In the first place there was no extra width of base, a very vital requirement, with rock asphalt, the screening mat was very poorly cleaned off, especially at the edges, also vital, and raking and edge tamping were done in a listless manner. As a result there have been numerous edge failures, not due to the base breaking down, which happened in only a few instances, but due primarily to the screening mat which produced a

slipping plane when wet. Disintegration, when once under way, is progressive and would carry across the road surface, unless checked.

As a contrasting sample, and in justice to rock asphalt, another sample should be cited. During 1919 and 1920 the State salvaged about ten miles of old macadam over Central Ohio, topping it with rock asphalt. The construction was all done carefully and practically nothing has been spent since on maintenance. Some of the above was built on old surface treated waterbound, some on plain waterbound, and about three miles on open stone. All about 15 ins. to 18 ins. overhang on the base. The open stone referred to consisted of a 4 in. layer of 2 to 4 in. stone of average hardness (Ohio Standard) over the old road widened. This open stone was carefully keyed with no filler whatever. It was necessary to dump the asphalt on loose planks and to re-key after each truck load, but the job is in perfect condition after four years of fairly heavy traffic on a main trunk line highway. On some of the surface treated macadam the base was painted, and on others it was not; there seems to be no difference in the present condition of the surface.

Cross Sections

I believe enough has been said as to what has been done in Ohio. The subject holds great possibilities, owing to the large mileage of moderate improvements. I feel it quite important to outline typical cross sections which should be used rather than to recommend any particular asphaltic top. In the first place the base whether gravel or macadam, should be of ample thickness to carry any reasonable traffic that might be expected to develop during the probable life of the proposed top. The asphalt top undoubtedly is the equivalent of a certain thickness of base; but when we are dealing with those cheaper bases, we can not afford to attempt to exercise minor economies and introduce a hazard at an expense of a possible additional 5 percent to 10 percent extra cost. I would estimate that the thickness of a gravel road should be from 10 to 15 ins., depending on conditions, and would naturally be near the low figure, if the road were subjected to a normal volume of traffic for years before resurfacing. Under no circumstances should a top of this kind be placed on a gravel road not subjected to at least one year's traffic. A macadam base should range in thickness from 8 to 11 ins. well built in courses of not over 5 ins., with the top well voided or entirely free from screenings, especially if a cold mix top is to be used. The base should in all cases have of greater width than the top, the width being greater with the cold mix types than with the hot mix types. A binder edging no doubt has its merits, but is not at all necessary; the money therein invested could be spent to much better advantage in extra width of base. The base should have an extra width of from 12 to 18 ins. on each side. Some will take radical exception to this on the grounds that the value of the extra base is lost, since traffic can not use it. This is wrong; to carry the width to the top would defeat the purpose of the base widening, which should be to keep traffic further from the edge of the base, thus decreasing the tendency of the pavement to increase in crown, and increasing its ability to reduce lateral yielding. The riding widths should be 10 ft. for a one track surface and 18 ft. for a two track surface; 16 ft. is acceptable in many places, but should not be standardized, in the writer's opinion, except on secondary roads. Under no circumstances should 14 ft. pavement of this type be constructed, as edge maintenance is apt to become very high, as has been evidenced in northwestern Ohio over a six mile section.

Conclusion

In conclusion I wish to make an appeal to you always to sell to your constituents a type, and not an estimate. By this I mean, that you should always feel certain that when a section has been finished it will deliver the goods and not develop weakness. It would be far better to clip off a mile of a ten mile section and get substantial construction, rather than to take a chance on the entire job, just for the sake of tonnage or yardage. Further, if your type costs more than the other fellow's, do not cheapen it in order to make a sale. Sell your goods, but sell them right. Remember, it is not ten good jobs alone that sells the next one; it is one bad job that cheats you out of ten others. The enemy will not cite your good jobs; but are often prone to go a long way, if necessary, to find a sample to suit their case.

The foregoing paper by Mr. Perry was read at the Third Asphalt Pavement Conference at Lousville, Ky., on Oct. 14, 1924.

DESIGNING STREET SYSTEMS FOR ESTIMATED FUTURE TRAFFIC

By Ernest P. Goodrich, Consulting Engineer, Regional Plan of New York and its Environs, 130 E. 22d St., New York, N. Y.

All problems as to traffic can be related to population, its distribution and activities.

Estimating Population

The first step in determining future traffic and the means of handling it is to reach a conclusion as to the future total growth of the community or communities under consideration. Certain laws of population growth have been determined with fair conclusiveness.

Growth is at first accelerated from a high birth rate and heavy immigration. The birth rate falls relatively to the death rate and competitive conditions restrict immigration. (The term immigration includes interstate shifts and the rural-urban movement as well as foreign immigration.) Changes in economic conditions (such as the whaling industry on New Bedford) have large effects.

Distribution of Population

The second step in determining future traffic is to assume the distribution of population within each community. Studies of population distribution show that it follows well-determined laws.

The average resident density varies inversely with the distance from the center of the community except for a flattening of its curve at the center. It varies similarly with distance from subcenters and main traffic and transportation routes. It is greatly influenced by topography and such artificial factors as large parks, cemeteries, reservoirs, railroad yards, etc. Immediate growth is affected by land values, the state of development of public utilities and transit facilities. It will be stabilized and sometimes limited by zoning ordinances and local restrictions.

Business Regions

Having fixed upon the probable distribution of the homes of the people, the location of their daily activities must be similarly determined. Definite ratios have been found to exist between the areas which need to be set aside for residences, business, industry, parks and circulation; 4,000 sq. ft. of land will house an average family of five persons. A 25-ft. front local store will care for 100 persons. It takes about 2,000 sq ft. of factory land per worker. In the average, eventually about 20 per cent of the population will be employed industrially. There are typical general conclusions which must be determined separately for each specific community. Topography evidently is a large factor in fixing industrial areas, railroad right of ways, etc., and zoning ordinances will assist in stabilizing conditions so that estimates of future land use will be fairly accurate.

Business Activities

Business methods and activities are the next factors requiring study. Two thousand years ago both the vehicles which drove through Pompeii and the city's streets were narrow. More designed his Utopia with "ample streets," 40 ft wide. During the past hundred years slave transportation has been successively replaced by better and better methods, culminating in the motor truck. Main transportation routes have grown to include successively, waterways, toll roads, railroads and free highways. When each family manufactured its own clothes the traffic could have been measured in one or two vehicles per family per month, used to visit neighbors, attend town meeting, or go to court. Within present memories, it was common practice for farmers to go to town on Saturday afternoons, thus producing two vehicles per family per week. Studies of many communities show one vehicle per family per day as the present day city traffic which visits residential areas. Certain figures with reference to local, commercial and to large industrial areas in one typical city are one vehicle per day per 5-ft. front, and per 1,000 sq. ft., respectively. This traffic is largely automobile and will grow as some function of the local registration (ignoring through traffic for the moment). In various cities the traffic has been growing from the one-half to the seven-eighths power of the registration. As far as can be ascertained from the meagre collateral statistics which are available, the annual average mileage per car has been about constant during the past ten years. It is hardly expected that it will increase greatly—furthermore, the car ownership is rapidly approaching a saturation point which is readily determined for each state and for most large cities.

Estimating Traffic

In order to estimate future traffic, it is essential next to know the average length of each trip, or the proportionate number of trips of different lengths. It is well known that short trips are much more numerous than long ones, both in city

traffic and in that in the country. Typical data have been supplied by the Connecticut state highway traffic census.

The following table gives the results thus obtained:

Length of Trip, Miles	Per Cent of Total Traffic
0-9	36.9
10-29	30.5
30-69	18.4
70 and over	14.2

Generally speaking, traffic quantity varies inversely with the length of trip. This is disclosed by analyses of traffic around large cities, from studies of ferry traffic, etc., as well as that from Connecticut.

Traffic Density Map

A traffic density map can be constructed on the basis of such data as that above described. The community is first divided into areas of as homogeneous use as possible, and as nearly equal in traffic origination. The traffic between each two such areas is then computed on the basis of their size, type and distance apart. Uusually it is not necessary to take account of distance except in the largest cities and in regional and state studies. A convenient method is to place pins on a map so located that differently colored strings can be run from each area to each other one by the best route. Such a study brings out clearly all needed short cuts and other possible improvements in the highway system.

Such studies based on present day conditions have been compared directly with traffic tallies and found to check with surprising concordance when carefully done. Obviously, in small areas, all through traffic must be segregated and separately treated. This can be done by the same general method. The latter is obviously applicable to the study of future traffic 5, 10, or 40 years hence, with correspondingly wide possible divergencies due to the impossiblity of determining the future population, its automobile ownership and other future factors with precision. Such a method is also obviously more trustworthy than would be a simple guess. Seasonal and hourly variations in traffic must be considered and factors applied to convert average data to that of the maximum hour, which later must be used in determining street widths. Traffic tallies and theoretical studies of acceleration rates, braking distances, etc., afford data as to the numbers of vehicles which can be operated over any given type of pavement of any assumed width. Data of these kind were presented before the Fourteenth National City Planning Conference in Springfield in 1922. Many data have been secured since that date but they all point to the figures there enunciated as conservative.

With such traffic numbers per moving line per hour and with the probable future traffic estimated (as above described), it is arelatively simple matter to lay down plans for future streets and roads adequate to care for future traffic requirements.

Location of Thoroughfares

With certain assumptions as to population, commercial and industrial density, it is an easy matter to determine the spacing and general arrangement of main thoroughfares. Thirty foot roadways serving single-family houses on lots 50x 100 ft. should feed into main thoroughfares spaced not to exceed 6,000 ft. apart. In two-family districts the spacing should be reduced to 4,000 ft. and for the average multi-family house district 2,500 ft. should be the maximum spacing between main thoroughfares. In industrial districts main thoroughfares should not be spaced to exceed 1,500 ft. and they should theoretically increase by units of 10 ft. for each 750 ft. in length as any street approaches the center of a community or other traffic destination point. If attention is turned to transit facilities, including the street car and the motor bus, it is believed wise to space thoroughfares one-half as far apart as the figures above given, permitting cars and buses to operate on alternate thoroughfares. All other traffic has been ignored in establishing these figures and additional streets and street width must be provided to care for it.

The foregoing paper by Mr. Goodrich was presented at the recent annual convention of the American Society for Municipal Improvements.

BACKFILLING TRENCHES AND RESTORING STREET SURFACES

By S. Cameron Corson, City Engineer, Norristown, Pa.

One of the greatest problems confronting engineers of any municipality is the backfilling of trenches and the restoration of street surfaces.

There are and have been methods innumerable devised with the one ultimate intention of bringing a cut street

surface back to its original surface and maintaining that condition. It is needless for me to state how unsatisfactory many of these so-called repairs have been When first completed, apparently the patch looks as good as the adjoining surface, but in a short time through the settling of the earth in the ditch or the pounding from heavy traffic there is a light depression, which soon ends in an ugly hole. Many methods have been tried. Some have proven very successful, but the majority are bad.

Competent Inspection Required

My experience has been that the best results are obtained only by having a competent inspector on the job all the time that a ditch is being backfilled to see that the filling is spread evenly in layers of not over 6 ins., preferably 4 ins., with two or more rammers to the one shoveler, this number depending on the length and size of the opening. Also to see that all the excavated materials except rock are returned to the ditch and if necessary to procure additional earth entirely to fill the ditch to the surface. This method is used on all of our sewer contracts and is specifically mentioned in its specifications and under the supervision of our inspector.

Then, by our ordinances, the filling is rounded or arched the entire length of the ditch and where the adjoining pavement is laid on a concrete base the opening is widened 6 to 8 ins. under the old concrete to insure a base for the new concrete arch. This ditch is inspected only when the arching or form has been made. We do not have a sufficient number of inspectors to stand over the many ditches opened every day to see to it that the earth or backfilling is properly rammed except as stated above for sewer construction under contract. Therefore, the inspector who examines the arching and the underneath trench takes it for granted that the ditch has been properly rammed. If he finds that a quantity of material (except rock) has been removed from the ditch he will refuse to pass upon the work and will then report to the office. We must then determine the cause of the removal of the dirt and how much has been removed. If, for instance, a 24 in. sewer has been laid at a depth of 6 ft., we know that the cubical contents removed can not be replaced, but if, for instance, a 1 in. water service is placed in a 6 ft. ditch and nearly a cart load of earth removed, then we know that that ditch has not been properly backfilled, and order it opened and re-filled the next time, if possible, under inspection. But that does not cure the evil. The ordinance referred to above requires a concrete arch over all ditches for all but waterbound macadam pavements.

It has been claimed by some that when repairing over a ditch in a brick paved street the bricks should be arched, thereby causing an error equal to a depression. It has been my experience that if a patch in a hole is too high then you make two depressions. This subject was the means of calling together a number of engineers and superintendents of streets from several states at the Engineers Club in Philadelphia, and I attended the afternoon and evening sessions and this subject of backfilling was discussed very thoroughly from all sides. And for your further consideration I desire to read to you later some of the expressions of opinion as taken at that meeting.

Many ditches are backfilled by the flushing method, particularly where the material excavated is sand, viz.: by use of water to distribute the sand or loose earth, but we find that flushing in clayey soils is dangerous and we have so many subsoils of that nature that our ordinances prohibit puddling or flushing of ditches. Although some of the sand could be flushed for instance, there is one exception which was made recently. Two years ago we paved our Main street for one block with concrete covered with Amiesite and an ordinance was passed prohibiting the cutting into this street for a period of five years, and the ordinance further ordered that all property owners should have water, gas, sewer or subway conduits examined and if any of them required attention to have the work done prior to a certain date so that that work would not hinder the contractor. Upon the expiration of the time limit the old street was torn up and many repairs to pipes made. The concrete was laid and covered with Amiesite. Shortly after this street was completed the managers of the Grand Opera House, after it was destroyed by fire, decided to construct an entirely new building and as part of the program they asked permission to lay a larger water service and sewer connection. Council granted them permission, provided they would tunnel under the new pavement. This they agreed to and did. The tunnel was so constructed as to have a slab of con-

crete 2 ft. wider than the sides of the tunnel and by constructing pockets of lumber the concrete was poured in under the old concrete pavement to a depth of 10 ins. to 6 ins. into 3 ft. long pockets. The next pocket to the 6 in. depth being 10 ins. diminishing to 6 ins. and so on. This was carried back to a known depth of 8 ins. of the old concrete in the street. There was no depression in the street nor any cutting of the surface over the middle of the tunnel. Where the west bound trolley track passed, the ties became loosened after the sub-grade had dropped into the tunnel. There were some very heavy storms and the rain found its way into the tunnel softening the side earth and requiring that the concrete top slab be widened to 12 ins. on each side of the tunnel to protect the street, all of which was done as per plan and properly sealed. Just prior to the construction of the tunnel, conduits were laid along the curb enclosing electric cables for our new street lighting system. Much water from melted snow found its way into the tunnel.

Sometime thereafter heavy iron and steel fittings were unloaded in front of the building and one slipped or fell on end striking the street a terrific blow. This was not known until a hole about 4 to 6 ins. in diameter was seen in the pavement. This was enlarged and a solid piece of concrete 8 ins. thick and about 20 ins. in diameter was dislodged and dropped into the hole. This hole under the tunnel roof was probably made by water seeping in along the curb during the thaws from snow and ice before the cables were laid in concrete. It was then found necessary to make a 2 ft. square opening at the track as there was a grade of at least 8 ins. from rail to curb and to fill this ditch completely, I ordered sand to be flushed into the upper hole, which entirely filled the opening under the concrete. This was allowed to settle a couple of weeks, then more sand flushed in and when this settled an opening all around both cuts was made about 9 ins. larger than the original cut. The sand was rammed in arch formation and concrete poured into this, bringing it flush with the old surface. After the concrete had set for a few days an Amiesite top was spread and thoroughly rammed. Since this has been finished, about three months ago, there has been no settling. (By this method 4½ cart loads of sand were forced into and under the old concrete pavement.)

One engineer at the Philadelphia Conference previously mentioned stated that they require a deposit of $50 when the application for opening a street is made. Then an additional deposit of $50 is required to insure that the ditch does not settle. The owner of the property is also required to pay for opening the ditch and for a concrete slab not less than 6 ft. wide and the length of the ditch. The width of this slab is determined by the width of the ditch, but in no case is it less than 6 ft. wide. The engineer was asked: "What becomes of the second $50?" He did not know. He had never known of its being returned.

The arch of concrete, as we do it, in Norristown, insures the closing of the surface opening and if properly constructed will sustain the surface pavement, but if the surface be made of Amiesite or any other soft bituminous compound, traffic will eventually drive it down in very hot weather and this may be remedied by refilling the opening or top coated space with more material.

The convention held at the Engineers Club in Philadelphia on February 20th, 1924, was replete in its having a full and complete discussion on the subject in question, repairs to street pavements and particularly that of ditches, cuts., etc.

There were many engineers present who gave their personal experiences, cost of equipment, method of repairing, etc. That of one engineer was particularly interesting in the matter of general statistics and the enormous area covered by the city's repair department, as were the remarks of another engineer who dwelt more particularly on the work of the different gangs, viz.: concrete, asphalt, wood block, etc., the wages paid and the amount of work each gang could do in a day were given. One statement, which I quote, is very interesting:

"The problem we have is the restoration of cuts. The corporations complain of cuts. We also know if we have no cuts we have no work. So there are sections in the City (New York) that I have in mind, where we have restored a cut in one day and it has been opened the next day, closed that week and repaired the next week. Our maintenance division did not know what was the matter; whether a hammer was left in the hole or what was the cause of all this. This condition keeps up indefinitely year in and year out."

As stated above both of these gentlemen went into many details, but they did

not tell us how the ditches had been backfilled nor how the street pavement had been relaid.

A question was asked one engineer: "Do the Public Service Corporations or the plumbers refill the trenches and what responsibility is there with regard to the original deposit if the repairs are not satisfactory?" In other words if a second repair has to be made?

The reply was in part as follows:

"A double deposit is taken, as we call it, estimated according to the purpose of the opening. An opening for water is generally considered about 8 yds.; a sewer connection 16 yds. A plumber is charged at the rate of $5 to $6 per sq. yd. on a regulation estimate. He then is charged an equal amount for a deferred payment, making the double deposit, but of the first half of his deposit his first restoration is made and he is charged only what that restoration costs. If the ditch or pavement has not settled in six months the entire balance of the deposit is refunded. If the pavement does go, then it is resurfaced and the cost taken from the second half of the money deposited. If this is not sufficient a bill is rendered to the person who deposited it. Very few bills for excess are sent out; not a dozen in a year. By this method the plumbers are trained to do better work in the backfilling of ditches."

Personally I can not see just how the plumbers are penalized as the owner of the property must reimburse the plumber for all deposits made and these are then made a part of the cost of the job, whatever the excavation may be for.

Another engineer suggested the opening be cut back under the adjoining pavement on to the old ground surface to get a better contact and bridging of the opening. This very method was incorporated in an ordinance referred to above, passed November, 1921, by our Council requiring arching over the backfilling after that fillinghad been rammed to form a centre for the concrete arch. In addition we require that a space of at least 6 ins. be cut out from under the adjoining concrete and then be entirely filled under the old concrete and over the center to a common level with the adjoining concrete. We have had splendid results from this method. And as this engineer stated it tends to form a "cork in a bottle" effect and is far superior to the old method of spreading the concrete on the same level with the old concrete. This arching method is used under all of our pavements with the exception of waterbound macadam. Why this was not included I do not remember except for the fact that kind of pavement is now obsolete.

The Commissioner of Philadelphia, who presided at the evening meeting, in closing the session said in part: "Gentlemen, we have had a very interesting discussion on this very important subject, but I fail to see wherein we have a remedy for the evil. In Philadelphia there are many very bad repairs of ditches in our pavements and I know that in every municipality in our land the City Officials are damned by the traveling public for want of a method that will effectually remedy this trouble. As I see it from this discussion we are now no nearer a solution of this serious problem, other than that by this and other similar meetings a way may be finally discovered by which this evil will be eliminated." These are not his exact words, but bear strongly to the text of his remarks. Many of you, if not all of you, must and do appreciate his remarks as being practically the verdict as we see it today. Except as stated in this paper I have found the arching of ditches to be one of the best plans yet submitted and the past three years justify that assertion.

The foregoing paper by Mr. Corson was presented at the recent annual meeting of the American Society for Municipal Improvements.

WABASH RIVER POWER STATION AT DRESSER, IND.

(Editor's Note: The present article gives some facts of interest about superpower as interpreted from the Wabash River Power Station of the Indiana Electric Corporation at Dresser, Ind., and may be considered as supplementary to the article entitled "Super-power and its Relatioin to Progress and Prosperity," published in the September issue of this journal.)

The Wabash River power station will eventually be of 100,000 kilowatt capacity, equal to 133,000 horse-power.

This power will be produced from five 20,000 kilowatt turbine engines, of which two are now installed. The capacity of these is 53,000 horsepower.

The station in which they are contained is so constructed that it can be enlarged from time to time simply by

lengthening it. When its full capacity is reached it can be duplicated farther up or down stream.

The boilers which feed steam to the two turbines will be eight in all, four being now placed. There are 14,400 running feet of tubes in each boiler.

Each boiler is fed by two mechanical stokers and is fed from bunkers above the boilers, to which the crushed coal is elevated.

The coal is transferred from the bunkers to the boilers by a traveling "lorry" car, which weighs, conveys and delivers the coal as needed.

The coal is conveyed to the bunkers over endless belts from the crusher, through the inclined structure at one side of the power station.

This coal is at present supplied from nearby mines, with no railroad line haul, the greatest transfer being a switching operation.

The company owns 4,000 acres of coal land adjacent to Wabash River Station, which will eventually be mined and feed its products directly into the crushers. This coal supply will take care of the needs of this station for half a century to come.

The full capacity of the plant requires 250,000 gals. of water per minute for condensing purposes. That is the reason why, in addition to being located on a coal mine, the Power Station is placed alongside the Wabash river. The Wabash river at this point has an average flow of 800,000 gals. per minute.

The rise of the Wabash river between low water and high flood level is 31 ft. Provision has been made against the extreme high water of the river ever affecting the operation of the plant. The condenser floor of the plant is 19 ft. below the high water mark of the Wabash river. The boilers are on the second floor of the power house. The reason is that the ashes drop into hoppers, which can be automatically emptied into railroad cars running on a track underneath, and can be removed without handling.

All foundations of the structure are anchored to the underlying limestone foundation by steel rods.

The buildings are wholly of steel frame with brick walls and limestone trimming. The turbine room walls are faced with ivory-gray faced brick. The condenser room floor and turbine room floors are composed of red quarry tile.

A railroad siding extends across one end of the turbine room to facilitate removals or replacements.

A traveling crane of 75 tons capacity, with four motors and a 15-ton auxiliary hoist serves both condenser and turbine room floors for the same purpose.

Completely equipped first aid and sleeping rooms have been provided for emergency use by employes or engineers in charge.

The office bay is four stories high, giving ample space for office and toilet accommodations for the chief, assistant and watch engineers.

The top floor of the office bay is devoted to electrical operating and control rooms and the load despatcher's office.

The coal supply underlying the property includes strata of the No. 5 and No. 3 Indiana veins.

A turbo-generator of 2,600 horse-power is installed for service in an emergency that would cause failure of the house supply of electrical energy from the main units.

Wabash river water is "hard," so that it must be evaporated and condensed for boiler use. Evaporator capacity of 20,000 lbs. of water an hour is provided to make up the losses of boiler water. This water is supplied to the boilers at 240 deg. In addition a tank of 50,000 gals. of distilled water is kept supplied for emergency use.

There will be four chimneys. One is now erected.

This chimney rises 275 ft. above the boiler room floor and is one of the tallest in the state. It is 17 ft. in diameter on the inside at the top. It is lined with radial brick from bottom to top.

The belt which carries the coal from the crushers to the bunkers is 24 ins. wide, runs at a speed of 300 ft. per minute and carries 100 tons of coal an hour from the ground level to the bunkers. Eventually there will be two such belts, capable of carrying 4,800 tons per day.

The concrete bunkers over the present boilers hold 1,000 tons of coal. Eventually they will hold twice this capacity.

The two forced draft fans used in connection with the furnaces have a capacity of 225,000 cu. ft. of air per minute.

Automatic annunciators in the turbine and switchboard control room indicate every interruption requiring immediate attention.

The out-door "step-up" transformer station at Wabash river station raises the voltage for transmission to 66,000 volts.

Provision is made for transmission to Indianapolis at 132,000 volts.

The out-door "step-down" transformer at Indianapolis reverses this process, stepping down the current after transmission to the normal voltages employed for distribution for industrial and domestic uses.

The transmission line from Wabash River Station to Indianapolis occupies a right of way 75 miles long and 200 ft. wide.

It has capacity to carry two steel tower lines, each capable of carrying a double circuit 132,000 volt line.

The towers are 80 ft. high, 20x20 ft. at the base and weigh 7,500 lbs. each. The angle and anchor towers weigh 10,500 lbs. each.

The losses of power by transmission on this line will not exceed 5 per cent.

The circuits are built to stand up under their own weight, plus an ice coating half an inch thick, plus the strain of a wind storm equal to a pressure of 8 lbs. per sq. ft. The towers are built to stand a wind pressure of 22½ lbs. per sq. ft. These pressures are far greater than any usual in Indiana. A telephone line parallels the transmission line.

Other "high" lines for distributing current at lesser voltages reach out in other directions from Wabash River Station, to feed the system controlled by Central Indiana Power Company, including nearly 150 cities and communities.

The cost of Wabash River Station, so far, is largely in excess of Ten Million Dollars. The cost of the Indianapolis-Terre Haute transmission line was in excess of Two Million Dollars. The cost of the Indianapolis transformer station was, roundly, One Million Dollars. The total investment in the system supplied from Wabash River Station is in excess of Thirty-Five Million Dollars.

The copper wire in the lines between Wabash River Station and Indianapolis necessitated the mining of over 30,000 tons of copper ore in Montana.

The Super-Power system of Which Wabash River Station is the first unit is so designed that it may be increased and enlarged to take care of the maximum demands for power likely to accrue in Central Indiana for the next quarter century. So long as demand continues to grow the likelihood of capacity of this source of electric supply will exist.

Wabash River Station has been constructed to be the backbone of the industrial growth of Central Indiana.

THE NEW SEWAGE TREATMENT WORKS AT WORCESTER, MASS.

By Ralph G. Lingley, Superintendent Sewer Department, Worcester, Mass.

Worcester, a city of 200,000 inhabitants, is located at the head of the Blackstone river, the most highly developed river as to water power in the United States.

Early Works

The second chemical precipitation sewage treatment plant in this country was constructed in Worcester in 1890, by Mr. C. A. Allen, then city engineer. Copperas was present in the sewage as a trade waste and lime has been the only chemical used. This plant is in use today and takes care of about 86 per cent of the sewage. In 1904, the first detritus chamber constructed in this country was placed in operation by Mr. H. P. Eddy, then superintendent of sewers.

From 1899 to 1910, sand filters to the extent of 74 acres were constructed and are now used to treat about 14 per cent of the sewage flow, after it has passed through two settling basins where the detention period is about 30 minutes. From 1904 to 1918 much experimental work along sewage treatment lines was carried on.

In 1919, the State Legislature enacted a law compelling the city of Worcester to construct a new sewage treatment plant to be ready for operation, April 1, 1924, which time was subsequently extended to July 1, 1925. In consequence thereof, the city government ordered an Imhoff Tank-Trickling Filter sewage treatment plant to be built which is now nearing completion.

Imhoff Tank-Trickling Filter Plant

The plant has detritus chambers, Venturi meter, Imhoff tanks, dosing tanks, trickling filters, secondary tanks, sludge drying beds, together with a modern laboratory building. The design is based on an average daily sewage flow of 28 million gallons from a population of 275,000 in 1940. The plant is located 3.5 miles south from the center of the city and adjacent to the sand filters of the present plant.

Description of Plant

The detritus or grit chamber consists of two channels, 85 ft. long and 8 ft. wide, the pit depth at the inlet end being 2.5 ft. and at the outlet end 4 ft., furnishing grit capacity of about 100 cu. yds. The design plans for sewage flows up to 67 million gallons daily with an average velocity of flow of about 1 ft. per sec.

Gates are provided for draining off the top water when a chamber is to be cleaned. The inlet gate is then to be opened and sewage used to scour out the grit through a 30 in. gate on to one of the present sand filters close by. After drying out the material can be scraped or carted to nearby spoil areas. It is expected that frequent cleaning will minimize any offensive odors. The design is such that cleaning may be done by a crane wtih a clam shell bucket.

From the detritus chambers, the sewage will flow through 1,100 ft. of inverted siphon, thence through the Venturi meter to the Imhoff tanks.

The Imhoff Tanks

There are 12 Imhoff tanks, each 60 by 90 ft. in plan with a water depth of 31 ft. Each tank has four sedimentation compartments, the slope of the bottom being 1.5 on 1.0 and all together give a 2.5 hours' detention period based on 28 million gallons daily. Open channels are used throughout and provision is made for distributing and reversing the flow of sewage. Scum boards are also provided.

Each tank has five gas vents extending the length of the tank, the middle three being 36 ins. wide and the outside two, each 18 ins. wide. The gas vent area is about 21 per cent of the tank area.

There are six sludge hoppers in each tank, 30 ft. square with a bottom slope of 1 on 2. The depth of sludge storage below a point 24 ins. from the 8 in. slot is about 17.5 ft., sufficient for a period of about five months. The sludge storage capacity is approximately 5.9 million gallons, representing about 3 cu. ft. per capita. Drains are provided for drawing the tanks down to the top of the sludge hoppers. Sludge pipes, 8 ins. in diameter will remove the sludge under head to adjacent sludge beds which will be constructed in the present sand filter area. Perforated water pipes will be placed on each slope for agitation of the sludge.

Dosing Tanks

The dosing tanks are in four units, each having two compartments, 30 ft. square, with twin alternating 36 in. siphons. Each unit doses one-fourth of the filter area, or 3.5 acres, under variable effective head of 7 ft. to 1 ft. One side of each compartment is so constructed as to assist in giving uniform distribution of sewage upon the filter. Each compartment has an approximate capacity of 36,500 gals and at the 28 million gallons rate of sewage flow, provides filter dosing and resting periods of three minutes each. At the maximum rate of sewage flow the dosing tanks will function but there will be practically no rest period of the filter. The channels to the dosing tanks have overflow weirs and are so arranged that the Imhoff tank effluent can be discharged directly into the river.

The Filter

The trickling filter, 752.5 ft. by 792 ft. in area, or 14 acres, is divided into two units and has 10 ft. depth of crushed granite and trap rock, screened through a 3-in. ring and held on a 1¼-in. ring. Each quarter section of the filter has a concrete main distributor decreasing from 54 to 24 ins. in diameter followed by a cast iron section decreasing from 20 to 12 ins. in diameter. From this main distributor are 8-in. C. I. laterals reducing in size to 6 ins. These distribution pipes are to be held in the top stone spaced so that the nozzles are staggered and 15 ft. apart.

The concrete floor, sloping to main drains, has concrete ridges, 15 ins. on centers, upon which are set precast cement mortar beams on edge, these beams being 16x4x1½ ins. These beams form a grid floor above the bottom and have open or air space of 43 per cent. Each half of the filter has two main drains which collect from 100 ft. of floor on either side and carry the effluent to the secondary sedimentation tanks. Inspection galleries are provided over each drain and at the ridges halfway between the drains. The filter is enclosed by a concrete wall and either half can be flooded if desired. Treating an average daily sewage flow of 28 million gallons, the rate of operation will be 2 million gallons per acre per day.

Secondary Basins

There are four secondary sedimentation tanks, one for each quarter of the filter. Each tank is 60 ft. by 120 ft. and 15 ft., water depth, the direction of flow being across the short dimension. Each tank bottom has eight hoppers, 30 ft. square and 7 ft. deep. Sludge pipes, 8 ins. in diameter, are provided and the sludge will be pumped to the Imhoff tanks or directly to the sludge drying beds. Based on the 28 million gallons daily rate of sewage flow, the detention period is 1.5 hours.

The elevations of the sludge discharge pipe from the Imhoff tanks and the sand filters of the present plant are such that about eighteen acres of the filters are available for sludge drying beds by pip-

ing to them and dividing into smaller units.

All buildings will be constructed of similar materials; shrubbery and drives will be provided and the grounds kept in as beautiful condition as possible.

The foregoing paper by Mr. Lingley was presented at the recent annual meeting of the American Society for Municipal Improvements.

MODERN METHODS OF CONSTRUCTING RESERVOIRS

By R. E. McDonnell, of Burns & McDonnell Engineering Co., Interstate Building, Kansas City, Mo.

The general term of reservoir refers to the storage of a reserve supply. A reserve supply of water is essential whether the water comes from wells, springs, rivers, impounding lakes, or any other source. It is the safety valve of the entire water system. A prudent business man will safeguard his family by insurance or safe investments. A far-seeing water works official will likewise protect the community by adequate storage reservoirs. It is an insurance policy that protects both lives and property. Its size and capacity is often inadequate, for in providing water improvements, if funds are short, the common practice is to cut down the size of the reservoir. Many small plants are operating with scarcely any reserve supply, but why should a water works official shoulder the risk and responsibility of trying to "get by" and flirt with danger?

Protection Against Breakdowns

The superintendent is treading on thin ice by putting all his dependence in the safety of pumps, pipelines and equipment. They are always subject to breakdowns, floods and unusual accidents. One superintendent's excuse for not coming to this water works convention was that he was afraid to leave home for fear of a breakdown. I'm wondering if that community would sleep peacefully at night if they knew the small margin of safety with which their lives and property is protected. The right kind of a water works official is fully justified in making known the needs of the water department and taking into his confidence the public, not by written reports, for they are seldom read, but by warnings before civic organizations and in the public press regarding the needs of his water department.

The Fire at Berkeley, Cal.

I recall clearly the disaster that happened at Berkeley, Cal., just a year ago. There the city suffered a loss of twelve million dollars, and in three hours, 1,200 of the finest homes in the city were totally destroyed. The circumstances surrounding that loss were unusual. The city had employed a city manager, who had previously had some water works experience in another state. He had been on the job less than one month and soon saw the need of larger reservoir capacity and larger feeder mains, and reported his recommendations toward a survey of the water needs. The city council replied that his advice was not new and such matters had been discussed for years. However, the manager insisted upon a report being made, but unfortunately their disastrous fire occurred upon the very day our engineers arrived to begin the surveys. Within an hour after the fire started, using twenty-five fire streams, the reserve reservoir was exhausted. Direct pressure through small diameter mains with their high friction loss produced ineffectual streams.

The Size of Reservoir

The size of a reserve reservoir supply as recommended by most boards of underwriters is three and one-half times the maximum daily consumption. Some cities have far greater volume than this. One western town, Flagstaff, Ariz., has fifty times its daily consumption, and will soon add another fifty million gallon reserve reservoir, their need of such a large reserve being due to the cold weather freezing through a porous volcanic ash ten to twelve feet deep, stopping the spring flow when a temperature of 20 to 25 degrees below zero is reached, and to tide over these extremely cold periods, a large reservoir is needed. The springs are at an elevation of over 10,000 feet, where low temperatures prevail. Reservoirs being such an important and also such an expensive feature of the plant, much time and thought has been given in recent years to the adoption of more modern methods of construction.

We can all recall the old, slow, tedious, and expensive methods of slip and wheel scrapers and hand shoveling for earth removal and how they have given way to steam shovels, excavating machines, tractors, etc.; also the changes in mixing, handling and pouring of concrete regardless of weather conditions. With the advent of modern methods, the saving in time is a big item, one ten million gallon

reservoir having been constructed in ninety-six days, the walls and bottom being poured in one continuous pouring with three eight-hour shifts. The roof slab, 318 feet in diameter and 9 inches thick, being poured in sixty hours. With modern methods of construction, concrete covered reservoirs are displacing the open reservoirs with their algae and filth accumulating features. It has not been unusual to fish drowned cats, dogs, cows, and even babies out of these uncovered reservoirs.

Water-Tight Reservoirs

In many of the earlier constructed reservoirs, there was too little attention paid to making them water tight, but now, by double floors, waterproofed concrete and various kinds of waterproofing membranes, these reservoirs are made absolutely water tight. By modern methods of construction, it is not uncommon now to have swimming pools of a million gallons or more capacity occupying and built on upper floors of fifteen or twenty story buildings.

Value of Reserve Supply

The value of a good sized reservoir supply can hardly be measured in dollars and cents, for in many instances, they have saved more than their entire cost by accomplishing:

1. Supplying the entire city when a break occurs in the main feeder of a gravity supply or pumping plant.
2. Supplying a portion of the water at peak hours of consumption, thus avoiding the necessity of larger pumps and pipe lines.
3. Enables pumping equipment to operate at uniform load, thereby securing higher efficiency in operation.
4. Avoids drawing too heavily on wells, ruining their yield, through pulling sand against well strainers.
5. Permits the smaller plants to shut down at night and the larger plants to have time for pump repairs.
6. Enables the electrically operated plants to fill reservoirs at off peak loads at lower rates.
7. Secures for cities lower insurance rates.
8. Frequently gives fire protection when a breakdown in mains or equipment occurs.
9. Often prevents an entire water famine for long periods of repair in floods or other disasters.
10. Gives to the superintendent and community a feeling of greater security and peace of mind in knowing their lives and property are well protected.

The foregoing paper by Mr. McDonnell was presented at the recent annual meeting of the Southwest Water Works Association at Topeka, Kas.

CONTINUOUS CITY PLANNING

By Jacob L. Crane, Jr., City Planning Engineer, 1002 Wrigley Building Chicago, Ill.

The advocates of city planning constantly stress the point that with the completion of a plan the battle is only half-won. Before we can expect a complete victory we must also carry through the other equally important phase of the operation, namely, selling the city plan to the public. It is my belief that in many smaller cities and towns the city plan is bound to be a failure or at best only half successful unless a third operation is also carried on. That is the continuous survey and city planning study. In this paper I wish to emphasize the importance of such continuous city planning technical work wherever a community has had prepared and sold to it a city plan.

Interpreting the City Plan

To begin with, a competent city plan is impossible of intelligent interpretation except by some one who helped to prepare it or who has given it exhaustive special study for the purpose of directing its application. For example, difficult points of interpretation arise in the application of every zoning ordinance, even in the smallest towns. Perhaps an oddly shaped lot cannot meet the setback requirements. A variation of the zoning ordinance must be made. Nearly always it is a question involving more or less technical knowledge to establish sound policy in such a matter. Another instance frequently encountered is that of the location through a new subdivision of a road which is laid down in the city plan, but whose line must be varied to meet reasonable subdivision requirements. It may be evident that a slight change in the location of the road must be permitted, but the decision determining its final location cannot be made very intelligently except by a technical man with the help of the planning board. In fact practically every detail of a city plan as it is carried out must be "interpreted" according to the detailed conditions encountered at the time, and this all requires technical judgment.

Changes Call for Constant Study

In the second place, every competent city plan is based on an exhaustive survey of existing conditions: resources, present development and tendencies of growth. But the conditions found in this civic survey do not remain the same. In spite of the control exerted by the city plan and zoning plan, new tendencies will appear. For example, a large tract of land which had seemed particularly available for fairly dense residential development may be taken over for a golf course, and this immediately alters the requirements in that district for roads, parks, playgrounds and schools, and for all the public services. Such a case occurred recently in a suburban town outside of Chicago, where 300 acres of land were taken out of the range of residential development by a Golf Club which will use it for at least 15 to 25 years. To cite other examples of unforeseen changes in conditions studied in the civic survey, such a project as the St. Lawrence waterway, or such a legal decision as the abolishment of "Pittsburgh Plus" may stimulate industrial expansion or harbor requirements beyond any possibility foreseen at the time of the civic survey. All of this points to the need for a continuous civic survey: A continuous recording of population growth and changing density of population, of industrial and commercial development, and of all the changing resources, requirements and equipment of the community.

Influence of New Inventions

Third, new inventions and their application create new facilities for public use which may entirely upset the soundness of a well-organized plan. The automobile has done this in a number of instances; the aeroplane may do it again. Furthermore, new ideas and new standards may cast into the discard features of importance in a city plan. A project to elevate railroad tracks through a town which later raises its standards and financial capacity to the point of requiring track depression illustrates this point. Only a continuous technical city planning service can take care of these developments.

Some unexpected event will require the entire revamping of a city plan. A great fire or earthquake will make possible and necessary projects which an earlier city plan would scarcely dare propose.

Finally, every city plan is laid out for only a definite limited period in the future, and as this period of 15, 25 or 40 years approaches its close, the city plan must be revised within and extended beyond its original scope.

These are some of the reasons why we cannot expect a city plan to be successful unless we add to the two-headed formula of "prepare a city plan" and "sell it to the public," a third, namely, "the continuous survey and the continuous interpretation and revision of the city plan." For such continuous city planning the civic survey must be kept up-to-date, the city plan interpreted and applied step by step, progress on the plan recorded, and the plan itself adapted to changing conditions. A "continuous city planning" unit might also look after the promotion of the city planning projects and of the coordination with development outside the territorial range of the city's activities.

Continuing Study Essential to Success

In large cities a special city planning department should always be maintained, and as a matter of fact in practically all of the large cities, such planning departments of various degrees of effectiveness are maintained. In the city and town under 50,000 the only feasible way to carry on continuous city planning is to have the consultant who was engaged on the preparation of the original plan also engaged, on the basis of an annual fee, to give adequate attention to the interpretation, adaptation and development of the city plan. A draughtsman might very well be installed to look after the collection of data and the preparation and revision of drawings. Furthermore, it is of very great importance that the city engineer and also the city manager, where there is one, understand the purpose and foundation of the city plan, and its application step by step.

No matter how much attention the consultant gives, the actual detailed preparation of plans will be in the hands of the city engineer. This is the reason why some training in city planning for all students of municipal engineering in the colleges and universities is of the greatest importance in their future work. Only a few of the engineering schools have realized this opportunity for improving the qualifications of their students in municipal engineering at a critical time in the development of this profession.

I am convinced that the city planners and the cities which hope to realize the promise of the city planning idea must add the continuous city planning item to their program. A technical department is

necessary, ranging from the occasional advice of the consultant, with perhaps a permanent draftsman, up to a fully-manned corps in the larger cities. City planning budgets should anticipate this expense, which is a sure economy in the long run.

The foregoing paper by Mr. Crane was presented at the recent annual meeting of the American Society for Municipal Improvements.

THE EFFECT OF INDUSTRIAL WASTES ON SEWAGE PROBLEMS

By Langdon Pearse, Sanitary Engineer, The Sanitary District of Chicago, 910 S. Michigan Ave., Chicago, Ill.

From the sewage standpoint, the effect of industrial wastes may be considered from several angles: First is the question of maintenance of sewers to avoid deposits detrimental to structure to secure freedom from local nuisance and freedom from explosive gases or gases dangerous to workmen in the sewers. Second is the effect of such wastes upon the operation of sewage treatment works where such are required. Third is the effect of such sewage upon the capacity for loading of the sewage treatment works.

The extent of the problem generally requires special investigation in each locality, in order to determine the nature of the industry, the amount of its wastes or its liability to accidental discharge of troublesome material.

The magnitude of the industrial waste problem in any locality will, of course, depend upon the relation of the production of industry to the human population. In case of the Sanitary District of Chicago, the industrial wastes from the packing houses, Corn Products Refining Company and tanneries aggregate easily the equivalent of 1½ million people as compared to the total human population approximating 3,200,000. In another case the effluent from a starch works is possibly equivalent to a population of about 175,000 people in a human population of around 50,000.

These are perhaps abnormal examples, but indicate the extent to which the industrial equivalent population may overbalance the human population requiring treatment. In an article by the writer printed in Municipal and County Engineering for January, 1918, the industrial waste problem with reference to the smaller cities was discussed in considerable detail. This will not be repeated here, but certain additional matters of interest will be discussed.

Preliminary Treatment

In the operation of sewers, however the need of preliminary treatment may arise where a rich industrial waste like that from a corn products works comes into a long outfall sewer, where the rich warm waste mixes with the human sewage and travels for a considerable distance.

A very vigorous decomposition may ensue, producing hydrogen sulphide, so that odors come up through the manholes at intervals and occasion complaint. Various remedies have been suggested, including a thorough investigation of preliminary treatment, together with the treatment of the waste before it leaves the starch works, to learn if the decomposition which ensues can not be kept in aerobic lines instead of anaerobic thereby oxidizing the bi-sulphite instead of allowing them to be reduced to sulphides. The need of such investigations may occur with other types of wastes from beet sugar works, tanneries and the like.

Maintenance of Sewage Works

On the two other topics, however, several points may be mentioned. In the maintenance of sewage treatment works, the effect of industrial wastes may be very obvious where such wastes contain oil or tar. In the operation of the Des Plaines River Sewage Treatment Works at times considerable batches of oil come down. Some of this appears to be from garages on the drainage area and some has been traced back as tar to a factory manufacturing roofing paper. In the latter case, much of the material reaching the sewer appears to have come through carelessness from handling tank cars on a side track, or in emptying tanks. Such oils in part float on the surface of the treatment works and may usually be removed by skimming, if need be. It would seem to be desirable so far as possible to require such material to be retained at the source. The inspection of industries and proper regulation of discharge afford some relief.

Effect on Sewage Treatment

In considering the effect of industrial wastes upon treatment, the problem for

the designing engineer is largely one as to the effect of the waste upon the loading which biological filters or activated sludge may carry, as well as the effect upon the sludge production in tanks or other preliminary treatment. According to the industry, the need of preliminary treatment before discharge should be studied. In the corn products industry, properly operated, there seems to be very little need of any screens or even settling, in that such suspended matter as comes is very finely divided and unless coagulated by lime will not deposit in sufficient amounts to pay for sedimentation.

On the other hand, in the handling of tannery wastes, both the use of screen and sedimentation may be well worth while as a preliminary to final treatment unless the percentage of industrial wastes is very low. The effect of the industry upon the sludge production will depend upon the proportion of waste. Industries such as glue works and tanneries discharge a large amount of spent lime which produces a large volume of sludge. Paper mills may discharge quantities of comparatively inert sludge of fibrous character. Other industries, like the corn products, discharge most of their organic matter in solution or very fine suspension, thereby having little effect upon preliminary sludge production.

Effect on Biological Treatment

The effect of the industrial wastes upon the biological treatment again depends upon the percentage of waste present and its character. Some wastes may have a sterilizing effect, as was shown by the copper salts present in certain outlets of the New Haven Sewer System in the tests made by Dr. F. W. Mohlman for Professor Winslow in 1918. In other cases, the presence of considerable organic matter may stimulate bacterial action and unless carefully watched may cause putrefactive odors. In the treatment of industrial wastes, the value of mixture with human sewage is often apparent to properly seed the mixture, and in particular in the handling of starch wastes, some of which at the point of origin are often sterile. In the effect upon the loading, the total amount of organic nitrogen present seems to have a bearing which apparently affects the activated sludge process more rapidly than the trickling filter. In the tests made at Argo for the Corn Products Refining Company under a cooperative agreement with the Sanitary District, Prof. Bartow, Dr. Mohlman and the writer have noted that when the total organic nitrogen of the sewage exceeds some 50 p. p. m. there is considerable difficulty in operating the activated sludge process without diluting the sewage. On the other hand, the sprinkling filter continues to function without showing like symptoms of distress.

There appears to be considerable data available on the handling of industrial wastes as such in the experimental work by the U. S. Public Health Service, by the Sanitary District of Chicago, and by the Massachusetts State Board of Health and other state agencies. There is, however, a rather meager fund of experience available as to the behavior of apparatus in different industries, and even less data upon the behavior of biological process in such circumstances. Further, in the application of sewage treatment on municipal problems, the proportion of industrial waste has not always been closely estimated, but has to be approximated. Use of the more modern methods of sewage analysis should encourage investigations in this field and more complete estimation of the loading coming from different types of industry expressed in oxygen demand per unit of production. With better knowledge of the behavior of biological sewage works based on a similar type of test, it is probable that the performance of sewage works can be estimated much more accurately in the future than has been the case in the past.

The experience of the writer in connection with the investigation of waste problems in the Sanitary District of Chicago and outlying territory emphasizes the need of a thorough study of such wastes, their character, composition and behavior in the planning of sewage works, and shows the value of extended investigation where such materials have to be handled on any large scale. It further emphasizes the need of foresight by operators of large industries in locating their plants where natural resources available for dilution will aid in postponing the day of complete treatment.

The foregoing paper by Mr. Pearse was presented before the recent annual convention of the American Society for Municipal Improvements.

SPECIAL ASSESSMENTS FOR PUBLIC IMPROVEMENTS IN MEMPHIS, TENN.

By C. C. Pashby, City Clerk, City Hall, Memphis, Tenn.

Numerous inquiries as to the methods by which the city of Memphis accomplishes its local improvements have come to the office of the city clerk. Many personal letters have been written in reply until now it appears to be a matter of sufficient interest to justify a formal statement.

The closing years of the 1890's brought about a marked change in the affairs of this city in that the limits were so extended as to increase the city's area by approximately 300 per cent. It is probable that the old city was densely enough occupied to have been able to provide most of the necessary improvements on the pay-as-you-go plan, but with the addition of large areas of farming or gardening lands the question of sanitation and paving became very difficult problems.

By special acts of the Legislature authority was granted to levy special improvement taxes for sewers and street paving which ran over a short period of years and were anticipated at the bank to expedite the work.

The city could not, at that time, issue additional bonds, being pledged not to do so while certain bonds remained outstanding.

Many years prior an attempt had been made to invoke the principal of local assessments for local benefits but the Supreme Court had looked with disfavor on the plan in Tennessee.

In 1907, however, another attempt was made and a measure which we refer to locally as the Front Foot Law, was enacted. The city was successful in this venture and the courts recognized the distinction between a tax and an assessment. While the state constitution required that all taxes should be levied at a uniform rate and proportioned to the value of the property taxed it did not deny the Legislature the right to assess especial benefits derived from local improvements. One was a charge on an ad valorem basis while the other is a specified charge.

Improvement ordinance number one under this act was tested and since that time upwards of 400 improvements varying from little alleys and places less than 150 ft. long to major streets four miles long have been improved under it; the costs have varied from a few hundred dollars to over one-half million. This method has stood the test of time in this community.

To begin with the initiative lay with the abutting owners and 60 per cent of the frontage was required to petition before the improvement could be undertaken. The difficulty of doing this in cases where titles were not positive made the borrowing of money against deferred payments of assessments almost impossible.

Another drawback was the fact that the most needed improvements were the most difficult to secure petitions for. The Legislature of 1909 corrected both these defects by giving the city the initiative and under the act as modified no serious difficulty has been met in carrying out any necessary improvement.

The improvements have included widening streets, open places where no street existed (although needed to connect existing parts of streets), building culverts, underground drains, wrecking or remodeling buildings, and in short, anything that is required to carry out such projects.

Streets are paved and repaved. In at least two instances gaps or skips were left in the improvement which were filled in with other front foot projects. In one instance a street was cut through private property to unite it with another street and the two streets were paved in both directions from the junction.

Ordinances are passed on three ordinances, being published on the day prior to each such passage. After passing the ordinance which describes quite in detail the work to be done, the termini of the improvement and the city engineer's estimate of the cost of each part of the work, the city clerk gives notice of a public hearing on the confirmation of the ordinance. The notice repeats the estimate of cost and puts abutting owners on notice to file protest, if they have any, against prosecuting the improvement. The ordinance may be modified, confirmed or abandoned. If confirmation takes place over protests of owners they have 30 days in which they may appeal to the circuit court. If no appeal be taken or no protest made the owners are estopped from questioning the work at any later stage so long as the advertised program is adhered to as to plan and cost, except that a 10 per cent increasing variation is permitted in individual items. If any item costs more than this limit the city has the option of absorbing the excess or

of receding and starting over. A flat charge of 10 per cent on all vouchered items of cost is allowed to cover overhead costs and this is computed and spread upon the roll as a part of the assessment.

On the completion of the improvement the engineer makes up the roll after making up a statement of the total cost plus the statutory 10 per cent and divides same into three parts. One-third is assumed by the city and is generally financed by long term bonds. The other two-thirds are apportioned to the owners between the limits of the improvement, the rate being the quotient obtained by dividing the two-thirds costs by the total feet of abutting property.

The property may not, however, be charged more than one-third of the value placed on the property for the city taxes in the year in which the improvement is done.

The book of assessments is filed with the city clerk and advertised for examination and a hearing on the assessments. So long as no extraneous charges are brought into the bill nor other irregularity occurs the abuttor has no recourse at this stage of the proceedings. On the confirmation of the rate by the board of city commmissioners the rolls pass to the city treasurer for collection. Any owner desiring to take five years to pay his assessment may do so by making application within 30 days from confirmation of the amount of the assessment. After that date on the failure to meet future installments when due the whole assessment becomes due and payable.

In collecting assessments the same processes are followed as in collecting ad valorem taxes and the assessments go ahead of all other liens except liens for state, county and city taxes.

The city does not have excess condemnation but has resorted to the device of having a trustee hold remnants of parcels purchased in making street improvements. These remnants are usually disposed of to good advantage.

The assessments nominally made against public grounds, churches, cemeteries, etc., are absorbed by the city in addition to its nominal one-third of the cost so that while the nominal division is on the basis of 33 1-3 and 66 2-3 in practice the division is approximately 45 per cent borne by the city corporation and 55 per cent borne by the abutting owners. There is a partial compensation to the city for this distribution in the fact that street intersections are lumped into the cost of the project so that the abutting property is, in fact, assessed slightly more than its share of the pavement immediately in front of the property assessed.

Property is not charged with any incidental benefits to offset the damages which it sustains by reason of change in grade or damage to improvements. These are paid for at face value as a part of the cost of the project.

Taken by and large the city has been very successful in handling improvements by this method. The latest addition to the city's powers under this plan was the right to spread the cost of opening or widening a section of street beyond the limits of the section to be paved. By this plan the cost is made much lighter on the parcels assessed; thus the owners within the limits of the paved portion pay two benefits, one for the pavement and the other for the benefit by reason of the street opening and this is made to extend to the portion opened.

No attempt has been made to invoke the district plan and we do not turn into the intersecting streets with any assessment.

We have no long drawn-out processes—no court decrees—no fixing of the rates absolutely before work can start.

Bonds can be sold against the projects as soon as they are under contract. The proceeds can be used on no other streets than those included in the series supporting the bonds and the collections from the owners on those streets are, in turn, allocated to the payment of the principal and interest of those bonds and the full faith and credit of the city is pledged for the payment of the bonds, principal and interest. There have been sold $4,115,500 of these one to five years' bonds. It became necessary to refund $745,000 before it was learned by experience that the owners' share would not measure up to the 66 2-3 per cent of the voucher cost of the various improvements; but the owners have retired $2,564,500 and there are outstanding now (March 13, 1924) $806,000.

At the last session of the State Legislature a long step was taken in advance by providing that set back lines may be established and the cost of same incorporated in later improvements under the front foot assessment plan. No steps have been taken, as yet, to apply this law.

The foregoing paper by Mr. Pashby was presented before the recent annual meeting of the American Society for Municipal Improvements.

CHOOSING ASPHALT CEMENTS TO SUIT TRAFFIC AND CLIMATE

By J. W. Howard, Consulting Engineer on Pavements, 1 Broadway, New York, N. Y.

The necessity of using asphalt cement of different degrees of hardness (penetration test) for different climates and traffics is well known; also the necessity of not injuring its ductility, pliability, malleability and cementing strength. The increase of heavy auto buses and trucks and the shoving effect of their brakes at all times, and the cracking effects of chains in cold weather on asphaltic pavements can be resisted only by making such pavements denser and firmer. Therefore, harder standardized asphalt cements are purchased and used, combined with more carefully graded mineral aggregates. For example, in 1923, when resurfacing Fifth avenue, New York City, 42d street to Central Park, pure asphalt cement having a penetration (consistency or hardness at 77 degrees F.) of 35, was used. For Broad street, Newark, N. J., in 1923-4, also carrying very heavy bus and truck traffic, a penetration of 40-45 was required. The other ingredients of these sheet asphalt pavements were the same graded sand and portland cement filler. It was the writer's duty to select the materials, and make daily analyses and tests of these two pavement compositions during construction.

These illustrate the need of using lower penetration asphalt cement for resisting heavy vehicles. For ordinary passenger cars where traffic is not very heavy, hard asphalt cements do not resist weather as well as softer ones.

When asphalt cement is needed to be stiff or hard, it must be at the same time fairly ductile, pliable and malleable. To attain these qualities, asphalt cement, made at the refineries, of the desired hardness (a few by fluxing, most by heat, steam and air) should be purchased. Attempts to reduce softer asphalts to harder ones by admixing brittle asphalts or by use of hardening chemicals or powders, should not be allowed, because while irregular hardness may result, the other necessary qualities are sacrificed and a brittle, and in the end weak, pavement is laid.

Many years ago when asphalt refining had advanced but little and only fluxing was used to make bituminous and asphalt cements, many patents were issued and trials made to harden, stiffen and vulcanize bitumens and asphalts by use of sulphur and its compounds, such as copper sulphate, iron sulphate, calcium sulphate, hydrogen sulphate. Many patents were issued in the United States, England and Germany between 1864 and 1904 with the *feature* of tempering, hardening, or stiffening bitumen, including pitch, tar and asphalt used in pavement compositions. Many pavements of record were constructed according to many of these patents, but with little success because they were too brittle. The ductility, pliability and maleability of the bituminous and asphalt cements in them were impared or destroyed by sulphur or its compounds.

Old Patents Covering Hardening of Bitumens and Asphalts.

Some of the old, expired patents issued between 1864 and 1904, which used one or another chemical salt of iron, of sulphur, or sulphur itself, etc., to harden or stiffen the bitumens and asphalts in their pavement compositions, are the following: *Boynton*, 61390—"Combination of hydro-carbon with sulphur." *Day*, 104562—This covers all sulphides and sulphates of metals, because it states: "Metallic ores as found in nature to have sulphur united with them, or metallic oxides with sulphur added to them," also saying: "The office of the substances is to harden the mass;" also "I am aware that it has been heretofore proposed to employ sulphur in combination with hydrocarbons for pavements." *Filbert*, 10896—Uses asphalt and sulphuric acid (hydrogen sulphate) and states that this "hardens the compound very effectually;" also says: "Sulphur may be used instead of sulphuric acid." *Saunders*, 119476—Uses brimstone (sulphur), bluestone (copper sulphate), with pitch, gas tar or resin, all being hydrocarbons and, like asphalt, are softened by heat and stiffened by cold, and when mixed with copper sulphate or other sulphates, are stiffened and hardened in the same as the hydrocarbon asphalt. *Filbert*, 120956—Uses rosin, pitch, coal tar, etc., with sulphuric acid (hydrogen sulphate) or sulphur. *Crawford*, 123458—Uses Trinidad or other asphalt or coal tar, and sulphur, and states: "It hardens, etc." *Eagan*, 139127—Uses bituminous matter, pitch, asphaltum or equivalent bituminous material, with sulphuric acid (hydrogen sulphate); he states that the mixture is varied "according to the degree of hardness desirable." *Heller*, 185529—Uses asphaltum, flour of sulphur (pure sulphur), also tar, and

says: "Sulphur aids in hardening the pavement." *Filbert*, 188614—Uses in the surface layer of the pavement "Trinidad or other asphalt with a sufficient quantity of sulphur to vulcanize the mixture." *McCoy*, 275507—Uses then what was then called petroleum waste oil (and which is now called petroleum residuum or asphalt) combined with copperas (iron sulphate) or blue vitriol (copper sulphate) and says it is done to harden the composition to any degree of hardness.. *Schillinger*, 425258—Uses sulphur to stiffen asphalt or bituminous material to "prevent" the composition "melting" when exposed in a "pavement" or on a "roof" to "great heat." *Chase*, 760183—Uses resin (a bituminous substance) with copper sulphate and says it is used for "hardening and setting" the composition, and the result will become harder with age.

Any Degree of Hardness Now Obtainable.

The feature, in these old, expired patents, of hardening bitumens and asphalts by means of sulphur and its compounds, as sulphates, sulphides, oxides, whether having metallic or other bases, is between 20 and 60 years old, according to the patent being considered. This feature is independent of whatever the other ingredients of the old patented pavements may be—whether stone, gravel, sand or even sawdust, etc., forming the body or mass, now called the "mineral aggregate" of pavement compositions. It is interesting to note that the hardening of bitumens and asphalts by means of sulphur and sulphates is very old and itself not patentable for about fifty years, and is an abandoned method since the advent of good asphalt cement of any degree of hardness desired, together with the ductility, pliability, malleability and cementing strength necessary for making good and durable asphalt composition pavements.

The foregoing paper by Mr. Howard was presented at the recent annual meeting of the American Society for Municipal Improvements.

IMPORTANT PRINCIPLES OF BRICK PAVEMENT DESIGN WITH RECOMMENDATIONS

(Editor's Note: Mr. Maurice B. Greenough, author of the following letter, is, of course, well known to our readers as a former secretary of the National Paving Brick Manufacturers' Association. He is an engineer by profession and was formerly a member of the engineering faculty of the Case School of Applied Science. He has made a close study of brick pavement design for years and is actively engaged with that type of construction at this time.)

To the Editor:

Mr. Willis D. P. Warren, in your August, 1924, issue, in his article under the title of "Important Principles of Brick Pavement Design with Recommendations" has, on pages 56 and 57, admirably set forth under five heads the underlying principles which should govern design of brick pavements. I do not recall having observed anywhere the principles as clearly and concisely defined as he has stated them. These five points alone are worthy of the attention of every engineer who has to do with brick pavements, in particular, and might wel be considered and studied by all engineers, including those whose practice does not yet embrace brick pavements.

I am interested in observing that Mr. Warren quotes from page 8 of my paper before the 1921 meeting of the Illinois Society of Engineers in respect to the object of the artificial base beneath a brick wearing surface, the quotation being:

"The artificial base primarily serves as a medium for the transmitting of loads and forces from the wearing surface to the natural foundation where they are fitly disposed."

I believe this statement is axiomatic, but like most ex parte quotations, it served one purpose in my paper and Mr. Warren makes it serve another in his article. The proposition which I submit in my paper was that artificial base and natural foundation could not be separately considered, but by the very nature of their functions and service, they had to be construed jointly. I argued then, and still maintain that the natural foundation is the ultimate support of the pavement, and that any artificial base beneath a brick pavement does no more than complement the natural foundation. As I see it, the artificial base is of great consequence or little consequence as affecting the structural characteristics of the pavement as a whole, depending upon whether the underlying soil is favorable to the support of the pavement or unfavorable. I then emphasized what I believe to be a fact, namely, that the artificial base of a pavement is not primarily constructed to hold up the pavement. It

serves substantially the only purpose which can reasonably be assigned to it, namely, to *transmit* forces from the wearing surface to the natural foundation, in such manner that the wearing surface is preserved in its integrity and without irregular displacement.

If Mr. Warren will read the report of Mr. C. A. Hogentogler, highway engineer of the U. S. Bureau of Public Roads, on the brick roads of Florida, published in the April, 1924, issue of Public Roads, page 18, he will there learn of a great yardage of brick pavement laid on sand, properly compacted, most of it with sand filler in the joints and all of such quality and character, that, without going to great length, Mr. Hogentogler describes it as having proved satisfactory, meaning by that, I believe, that such brick pavements built for Florida conditions satisfied Florida conditions. Such a type of construction is a far cry from the typical designs shown in Mr. Warren's article. While there may be localities where Mr Warren's designs would satisfy conditions, economically, such a type would not be economically advantageous in Florida. There the subsoil is unusually favorable to pavement construction. Climatic conditions are mild and brick pavement of the sand filler, sand base type is built because, and not in spite of the fact that at the end of a period of years the pavement can be rebuilt, using again the same brick, to meet the new conditions as they have then developed in a State whose economic status is not yet fully stabilized. This is a feature of pavement service which engineers generally are not adequately recognizing. It is appreciated in Florida to the greatest extent of any section of the country because the state of Florida is conscious of a future before it. In some proportionate degree it should be reckoned with as to every pavement built anywhere in the country. Much consideration is being given to the trend of traffic and probably traffic at some future time, but generally speaking, and excepting the notable case of Florida, engineers are not considering the adaptability of their pavements to such changes as may take place in the future, when they build their pavements in the first place.

The fifth and last of Mr. Warren's principles in substance summarizes all of his points. I will quote it:

"The most economical brick pavement is one in which the various materials composing it are assembled and combined in such a manner that each shall most effectively serve the purpose for which it is intended, to the end that the resulting structure as a whole shall not only possess the requisite strength and durability, but moreover, that it ssall be low in first cost and low in annual maintenance cost."

The type of construction which Mr. Warren sets forth in his typical crosseition is not compatible with his requirements "that it shall be low in first cost." The reinforcement of base which he shows is equal in cost to approximately 2 inches of additional concrete depth and the added expense of his edge design would amount to nearly another inch, and certainly he would not maintain that all brick pavements should be designed to be equivalent in first cost to a 7-inch concrete base basis. In order to develop my thought on this point I wish to take a position diametrically opposite to Mr. Warren's, when on page 58, in discussing reinforcing he makes the statement that "the Bates Experimental Road tests are of considerable interest for they demonstrate the necessity and value of reinforcement in a most convincing manner." Let me first say that I agree with Mr. Warren if that statement is applied to concrete pavement built on subgrades similar to the Bates soil. But as applied to brick pavements, I assert, without fear of contradiction, that there is nothing in the official records of tests of such sections of brick as there were on the Bates road which to any degree show that heavier edges are needed for brick pavement, either curb or base, than a uniform depth of base. What Mr. Warren has done has been to reason from requirements necessary to compensate for the edge deficiencies of the concrete type to the edge requirement of the brick type and there is not sufficient likeness between the two to support such a line of reasoning. Were there two weak corners at each side of a a brick pavement base every 30 to 40 feet or closer, or if it cracked promiscuously as concrete pavement is apt to do, or such as are found at the ends of each expansion joint in a concrete pavement, then there would be some concern to reinforce this weakness. Such joints do not exist in the concrete base under brick pavement and the provision which Mr. Warren suggests in his edging design flows out of mistaken premises in brick pavement design and an excess of zeal to anticipate a condition which is not met in brick povement service. His suggestion

amounts to needless expense. He defeats his own premises that low first cost can and should be obtained. Lest I be misconstrued in my references to the Bates road and the application of the results of the tests thereon to concrete and brick pavement design, respectively, let me say that I do not believe that simply because some concrete slabs showed a critical corner weakness as built and tested on the Bates road, that it necessarily follows that the same corner weakness would be manifest on another corner built in the same way twenty-five miles away, unless subsoil conditions were analogous. Any engineer who would build a pavement on a subgrade as illy conditioned by nature to support a pavement as was the subgrade of the Bates road, could justly be convicted of professional neglect. A more disadvantageous pavement location could not be conceived. It might better have continued to serve as a corn field. That this is the case is proved, to my own satisfaction, at least, by the fact that the official test after having been conducted for a short period in the spring of the first year, following a period of heavy rainfall lasting the best part of a month, was discontinued altogether until sufficient time had elapsed for the soil to resume a condition wherein it could support the loads on the pavement at all. If I am correct, this vacation period in the test lasted at least thirty days. If the tests had been conducted as they were started instead of discontinued, there is no doubt in my mind that all of the Bates road would have been broken up promptly and completely. I again assert that any engineer who would build concrete, brick and asphalt types of paving on a subgrade which during a heavy rainfall would require traffic to be barred from it, could be justly convicted of professional incompetence. And reasoning from Bates concrete behavior to universal brick behavior is equally indefensible.

The point of all this is that it is utterly impossible to lay down any specific cross-section for a brick pavement or a concrete pavement, or an asphalt pavement, and say that such a single cross-section is the proper one to use in every mile of such pavement that may be built anywhere in the country. As to wearing surface in a brick pavement or an asphalt pavement it may be standardized to the last detail with due regard to variable depth according to present and prospective traffic requirements. As to foundation or artificial base those two elements never can and never will be standardized if good sense prevails. In the first place natural soil is not standardized, it varies throughout the length of a single highway or street paving project. It varies between localities. In one place it is adequate to support a pavement and in another it is not. I admit that defective places in a subgrade may be remedied by excavation, backfilling with suitable material, or underdrainage or a combination of both, but Mr. Warren's article does not consider such treatment either for country roads or city streets. I submit that good judgment dictates that it is far better to treat local defective places in the subgrade in the manner indicated or by any effective method, than it is to over-design the artificial base for the entire length of the pavement, provided the balance of the subgrade is capable of supporting the pavement. Mr. Warren may say he is speaking primarily of city streets, to which I would answer that it is no reply to over-designing the base of a city street, simply because there is an expectation, more often not realized than realized, that back filled trenches will not be substantially made. I maintain that an engineer competent to design and construct paving should be competent to secure by his own forces or from a contractor under him, such back filling of trenches as will remain stable and firm under his pavement and it is no compliment to him to beg the question by over-designing the base of his pavement.

Referring again to the base sand of Florida as set off against Mr. Warren's reinforced concrete base, Mr. Warren takes no recognition of all the other kinds of bases that may be used beneath a brick pavement which is specifically pointed out in my paper before the Illinois Society of Engineers from which Mr. Warren quoted ex parte. There are too many gravel bases, there are too many crushed stone bases, there are too many reconstructed macadam bases beneath brick pavements to deny such bases a place in the economic scheme of brick pavement design. Their utility past, present and future, can be clearly seen and established when examined according to the relationship between artificial base and natural foundation which I have set forth above. Such bases have proved themselves by past experience and will continue to have a wide usefulness in brick pavement design because they appeal to the sound, logical, common sense of the man who pays for the pave-

ment and no amount of theory in the end can prevail against common sense.

Mr. Warren adheres to his principles when he approves the 2½-in. brick wearing surface, adequately supported and without actually saying so, he emphasizes an outstanding economic advantage inherent in all brick pavements. He recognizes a 2½-inch brick wearing surface and a 3-inch brick wearing surface. I do not find in his article where he recognizes 4-inch brick wearing surface and it is apparent that inferentially he has given us to understand that a 3-inch wearing surface is suffiiciently deep for any brick pavement where the support is adequate. In this I believe that he is sound, speaking from some study of brick pavements laid throughout the country. There are some localities which still feel that the maximum depth of wearing surface should be 3½ or 4 inches but in consideration of the use of asphalt filler it is evident that the construction of the 4 and 3½-in. brick wearing surface is on the decline, whereas, the construction of 3 and2½-in. wearing surfaces is in the ascendancy. Seabreeze, Florida, is laying 60,000 square yards of 2⅝-inch brick on sand with sand filler, which may shock some orthodox friends. The Ohio State Highway Department, which for some years has used 3½-inch vertical fiber asphalt-filled brick for its highway work now uses, I believe, a 3-inch brick wearing surface. It is apparent that brick paving practice is working to a point where we may have three depths of wearing surface to meet three conditions, namely, 2½-inch, 3-inch and 3½-inch wearing surfaces for light and medium traffic, medium and heavy traffic and extraordinarily heavy traffic, respectively, and thus is being established the same economic adaptability for brick pavement as has been tacitly recognized in asphalt construction for a great many years. Asphalt pavements have been built of varying depths of wearing surface or with or without binder, according to type and conditions. Such development provides a proper solution of Mr. Warren's requirement for a minimum first cost, which I presume he intended to mean minimum with respect to appropriate satisfaction of requirements of a given street or highway. It provides a type of brick pavement the first cost of which, in one section of the country, namely, the South, wherein the spread of cost between concrete and brick is the greatest of any section unless it be the far West, clearly comes within less than 50c a square yard of first cost of concrete of minimum design, and substantially equal to or less than the cost of concrete when the brick are laid on any other base than concrete base. The gravest error that Mr. Warren can be charged with is that he has not surveyed brick pavement design, construction and use nationally in using the illustration which he has for his fundamental principles. His fundamental principles are admirably sound, his illustration is provincial, but to that extent he has erred no more than most of us in the paving business are prone to err when we attempt to prove a general proposition by specific illustrations. We select a few specific illustrations and frequently attempt to prove a general proposition by citing one street or one road or one locality. I know I have done the same on occasion. Mr. Warren has fallen into a somewhat similar habit of thought.

I probably have presumed upon your good nature in discussing this article to the length which I have, but I would like to make one more point in closing. The 2½-inch brick which Mr. Warren advocates is not among the recognized sizes of the Committee on Simplification of Varieties and Standards of the U. S. Department of Commerce. Having had some part in the work of this committee in its earlier stages and believing firmly in the benefit to the engineering profession as well as to the public generally which has come from the work of this committee (and which will come in greater degree as time goes on) I believe that I can say there is no conflict in consideration of the use of 2½-inch brick with the purpose of this committee. It is not the function of this committee to give the status of "recognized" sizes and variety to any arbitrarily selected type or kind of brick, nor is there any disposition on the part of the committee to discourage the use of a size or kind of brick outside of the recognized group. It does say that such bricks are to be regarded as specials until their use shall have advanced to a point where the proportionate amount of such brick is sufficient to warrant its recognition and the machinery of the committee is established to reinstate types and sizes once eliminated or to recognize new types and sizes as they may develop. This in no wise conflicts with the fundamental purpose of the committee which is to eliminate from recognition unnecessary sizes, nor is it the purpose of the committee to

keep from recognition any variety or size which proves by use to have sound economic merit. If, as many believe, the use of 2½-inch brick shows growth and development of a substantial character, I have no doubt it will be recognized by the committee. Even then it will have no worse standing than that of a special brick in the mind of this body.

Very truly yours,

MAURICE B. GREENOUGH,
Vice-President Southern Clay Manufacturing Co.,
Chattanooga, Tenn., Sept. 10, 1924.

STREET LIGHTING AND VISIBILITY

By Edward J. Stewart, Glasgow Corporation Lighting Department, Glasgow, Scotland

(Editor's Note: What follows is from a paper presented at the recent Annual Conference of the Institution of Public Lighting Engineers and Superintendents in Great Britain.)

The purpose of street-lighting is to make visible "the street;" more exactly, to make visible certain objects in or adjoining the street.

Candle-power of source, distribution of candle-power from the source in its system of reflectors and refractors, mounting-height, position, and spacing, are of obvious importance in securing particular degrees of illumination in a street and of visibility of its contents. For the theoretical street of, say, the maker's catalogue, no other consideration is required, unless the fixing of the "class" of the street, business, residential, and so on. But in the actual street, firstly the visibility of objects is not necessarily strictly proportionate to the illumination, and, secondly, there are other factors which affect both illumination and visibility.

The provision of a certain number of units of certain candle-power, or of a certain flux of light on the street ,or of certain foot-candles of illumination, average or at prescribed points, may have to be taken as legal criterion, say, to satisfy a public lighting authority of the performance of a contract. Some result, however, which can less easily be set down in figures but which is expressed in the vague phrase "good lighting," or, one may suggest, "good visibility," is needed before the general public or the conscientious official of the lighting authority is really satisfied.

Requirements of the Public

It is giving the public what it wants, at the same time leading hitherto loose and confusingly various individual preferences to become wants for the right kind of lighting, that the public lighting authorities and their engineers and superintendents have so useful a field.

On their work the eye of the ordinary user of the street, pedestrian, or driver, is the final judge. You may tell a pedestrian that fittings and their positions are all admirably calculated to safeguard his eyes from the glare, and to yield, and have been proved to be yielding, a practically uniform illumination, sufficiently high according to a recognised scale. If he says he thinks the street dull it is difficult to convince him that he is wrong. You may asure a motorist in the same street that the illumination has been specially designed for his benefit, and he may complain that he can not see people coming out from the pavement 50 yards ahead and that recurring glare is disconcerting; it will be difficult to convince him that the lighting could not be improved.

Should any user of a street be involved in an accident at night, either as injured or injurer, he, or his lawyer, is quite likely to attempt to shift the blame and any claim for damages to the apparently convenient shoulders of the local authority, on the ground of "insufficient light," even although the same accident might have happened, and similar accidents do happen, during broad daylight. Photometric measurements may, or may not, convey a definite impression to a jury, not to speak of a judge. Even with statistics and plans, one can form a correct notion of the visibility at a "locus" only by actual sight of the place. In the legal aspect, the opinion of the expert regarding lighting might be taken by the layman as final, if his numerical standards were officially adopted; but, in deciding his own "feeling" whether the lighting of a street is "satisfactory," every one will accept the judgment of his own eyes only.

Also there is not, yet, an eyesight test for drivers of motors or other vehicles through our streets. Perhaps that will come—and for pedestrians before they are allowed to cross the busier thoroughfares.

Lighting Standards

Further, the standard of judgment of street-lighting by the public does not remain constant, but rises with the progress of the lighting itself. The person who has been brought up in the coun-

try and wandered without thought of anything amiss along pitch-dark roads, will, after a few years' residence in town, clamour as nervously as the native for the safety of still greater illumination. Those of us who lived in town when flat-flames were the only light and were quite satisfied became equally satisfied with nothing less than the always increasing candle-powers which prevailed at each successive period. Every brightening of a street stirs discontent with the lighting which formerly satisfied in other streets or towns. The lighting engineer, in trying to satisfy the public demand for light, is creating dissatisfaction. It may be asked whether the power to discern objects at certain distances varies not only broadly with the illumination, but also with the difference from the illumination to which the observer has been accustomed in similar criterion.

Street lighting has thus a psychological criterion.

It is this psychological element, together with other incalculably variable factors, that forbids the circumscription of street-lighting into a few formulae. Standardization, for the sake of efficiency and economy, is one of the prime needs of street-lighting, both at large and in reference to any single lighting department: but that does not obscure the value of remembering that street-lighting demands recognition of the existence of many individual problems. It is all the more desirable that the onus of carrying out this function should be laid upon one responsible department. Fortunately, certain general methods can be suggested as good practice in any normal street, also certain general specifications of plant; a lighting engineer with full control of these resources can ensure that the application is flexible enough to give the best visibility possible of the particular objects in question. He can pay attention to special points in streets demanding special lighting; he can meet complaints, if they be well founded. He can meet his own complaints. The lighting superintendent ought to be even less easily satisfied with his own defects than the public.

Uniformity of Illumination

The tendency in street-illumination during the last few decades has been to secure higher candle-powers and at the same time more uniform illumination. In some of our Glasgow streets a "diversity factor" of fifteen to one has been attained, minor shadows not affecting visibility excepted. For most streets the ratio of maximum illumination is much greater.

There have not been wanting critics who have declared that uniformity was not necessary or even desirable for the securing of correct conditions of visibility throughout a street. The value of contrast is emphasized. Objects are believed to stand out better, for direct vision, still more for silhouetting, when there is some variation in the illumination of such objects at different points in the street and in the brightness of the street itself as background at one place and another.

Certainly we have sometimes felt in our own street equipped to give the greatest uniformity and least contrast that objects did not "stand out" prominently, although everything was actually visible for a long distance. Outsiders have also voiced the opinion that they could not "pick up" objects at a distance and generally that they disliked the softened outlines.

As a matter of fact, we rarely come near to the absolutely shadowless uniform illumination condemned in anticipation, and most streets could do with levelling up.

It is usually accepted, at any rate, that there should be greater uniformity in the passage between brightly lit thoroughfares and more moderately lit side streets. This is an argument for the placing of lamps at corners. There is such a fault as over-lighting, locally at least, and it holds possibility of accident. Sudden changes in the same street are also bad. The worst is usually at the last lamp, which may be quite a modest one, at the boundary of a town and the total darkness of the country.

Light Reflection from Street Surfaces

This is a factor in securing visibility of objects to which it is desirable to pay great attention. tI is another of the matters in which other municipal departments can give much assistance. Let us induce the department responsible for the making and upkeep of streets to provide the surface which best reflects the light.

The appearance of clearness in the streets of central London is largely due to the smooth surfaces of the roadways. Many of our Glasgow streets give little help in this way, but some do show the contrast. Best is the effect with those smooth surfaces which appear greyish or even whitish during the day and brilliantly reflect the light. There are other as-

phalt coverings which appear dark during the daylight but whiter at night, wtih good reflection of the artificial light. Less efficient are our granite setts, especially with sunk and rather wide interstices. Better are the closely fitted level setts. Poorest is ordinary macadam.

The influence of the surface is most striking in side-streets lit with ordinary gas-mantles. In one where the roadway is laid with macadam or setts there will be heavy, dark patches between the lamps; looking from a main thoroughfare with the large units, one will judge the side-street poorly illuminated. Yet another street with the same mantles at the same height and spacing may show up objects apparently as clearly as the main street. The effect is due to the bright background, against which any object is at once silhouetted.

Te effect is best where the traffic has polished the surface so that the light from all the lamps in view is reflected to the eye as from innumerable small mirrors. Wherever one goes these also shift, but they remain almost omnipresent.

Cleanliness of such a surface is naturally important, as is obvious where mud has been allowed to gather.

The effect differs according to the dryness or wetness of the surface. When such a smooth surface is wet the specular reflection at certain points is heightened, but the general tone of the surface is darkened and the continuous reflecting background of the dry surface is lost. With water all over, however, there may be compensating reflection. In Glasgow the wet effect is produced, apart from rain, by the hosing at night of the central streets.

Compromise

Street lighting is at every turn a compromise: between high illumination and low cost, between many lamp-standards and few obstructions, between distribution and diffusion, between high candlepower and glare, between uniformity and necessary contrast, between vision by reflected light and by silhouette. In finding that practical compromise, the lighting engineer may be helped by examination into the effect of the various factors mentioned and of others. His own and his colleagues' experience will yield much, and the psychologist, physiologist, physicist, and technician, can mutually assist, remembering that the final judgment remains with the eye of the user in the street.

MODEL STATE LAW FOR STREET AND HIGHWAY LIGHTING

(Editor's Note: It is necessary for a state to enact a suitable law in order that its subdivisions may be permitted to contract for public lighting. There has always been some provision in the laws of all states permitting the ordinary type of street lighting. There was no provision for special lighting such as Whiteways. Recently a number of states have amended the original law to provide for this new condition. Within the last year the same necessity has arisen with respect to highway lighting. There are still a great many states who have not passed laws covering Whiteway lighting, and with one or two exceptions, none of the states have passed laws covering highway lighting. In the states where such legislation exists, there is no particular uniformity in the laws, and provision is not always made to cover all possible conditions. Following is presented a model law covering every class and condition of public lighting and embodying all the good points of previous legislation. It was prepared by the cooperation of legal and scientific minds.)

Article I—Towns

Sec. 1. Establishment of Lighting District.—It shall be lawful for the town board of any town in this state to contract for the lighting of the streets, avenues, highways, public places and public buildings therein, outside of the corporate limits of any incorporated village in said town, upon such terms and for such time or period, not exceeding ten years, as the town board may deem proper or expedient, and to provide for the payment of the expenses thereof and may establish one or more lamp or lighting districts therein. It shall be lawful for the town boards of two or more adjoining towns in this state, whenever a petition for the establishment of a lamp or lighting district shall cover territory lying in two or more such adjoining towns, in this state, to contract for the lighting of the streets, avenues, highways, public places and public buildings therein, outside of the corporate limits of any incorporated village in said towns, upon such terms and for such time or period not exceeding ten years, as the town boards of two or more adjoining such towns in joint session assembled may deem proper or expedient and to provide for the payment of the expenses thereof.

Sec. 2. Petition for Lighting.—Where there is no lighting district already formed within the town, and the expense of the lighting provided for is to be assessed against the amount to be collected upon the taxable property of the whole town, no petition or establishment of district shall be necessary. When the expense of the lighting provided for is to be assessed against the taxable property of a district or there is another lighting district or districts already formed within the town no such contract shall be made unless a petition for such lighting, signed by a majority of the taxpayers, of such lamp or lighting district as the same appear upon the last preceding assessment roll shall be filed with the town clerk of said town 30 days before the contract is made, but in the counties of (specified), no such contract shall be made unless the petition for such lighting is signed by a majority of the resident taxpayers in such lamp or lighting district, unless it be a renewal or extension of such a contract. In case such proposed lamp or lighting district lies in two or more adjoining towns, a petition signed by a majority of the taxpayers of such lighting district as the same appear upon the last preceding assessment roll of such town may be filed with the clerk of any such town, and a copy of such petition and its signatures, certified to be such by the clerk of the town with whom the original petition is filed shall thereupon be filed with the town clerk of each other such town, and such petition shall not be deemed filed within this section until so filed with the clerk of each such town. A joint meeting of the town boards of such towns for the purpose of transacting any business of such joint lamp or lighting district shall be held at any time upon written request of the supervisor of any such town to the clerk of each such town. It shall be lawful, however, for the town board of each town, a part of which is included in a joint lamp or lighting district so established, to transact all business thereof in separate session, except that the establishment of the district and the adoption of an initial contract for lighting shall be done in joint meeting as provided in Section One. For the purposes of such joint action in separate session a majority vote at a meeting of each town board, upon the same resolution, shall be necessary. The town clerk of each such town shall file a copy of such minutes of separate meetings as refer to such lighting district with the town clerk of each other town, a part of which is included in such joint lighting district, and the action of the several town boards shall thereupon become effective for such joint district.

Sec. 3. Notice of Presentation of Petition.—The town board, or if such district shall lie in two or more adjoining towns, then the town boards of each such town, shall cause notice of the same to be published for one week in one or more of the newspapers published in such town or towns, or if no newspaper be published in such town or towns, then by posting said notice in at least six public and conspicuous places in said district, of the filing of said petition, and the time and place when the same will be acted upon by said town board, or if such lighting district lies in two or more said adjoining towns, then when the same will be acted upon at a joint meeting of the town boards of such towns, to be held in the territory where such district is to be created.

Sec. 4. Consolidation of Lighting District.—Two or more adjoining lighting districts in the same town may be combined in a single lighting district by a resolution of the town board of said town, and two or more adjoining lighting districts, lying wholly or partly in different towns, any one of which lies in two or more adjoining towns may be combined in a single lighting district by resolution of the town boards of such towns in joint session. In case the existing contracts for lighting different parts of such combined district are, by the terms thereof, to expire at different times, no renewal of any such contract shall be for a period longer than the unexpired portion of the term of the other such contract, if there be but two, or in case there be more than two such contracts, for a period longer than the unexpired portion of that one of such contracts which has the longest time to run.

Sec. 5. Extension of Lighting Districts.—Any existing lighting district may be extended by resolution of the town board of the town in which such district is situated, or by resolution in joint session of the town boards of the several towns in which such district is situated, so as to include therein any part of such town or towns, adjoining such district, upon the written petition of a majority of the taxpayers as the same shall appear upon the last preced-

ing assessment roll, owners of real property to be included in such proposed extension, duly filed with the clerk of the town in which such district is situated; or if such district lies in two or more adjoining towns, with the clerk of any one of such towns. A lighting district may be repeatedly enlarged and extended in accordance with the provisions of this section. No contract for lighting such extension shall be made for a period of time longer than the unexpired portion of the term of the existing contract for lighting said district; or, in case there shall be at the time of such extension more than one existing contract for lighting said district, for a period longer than the unexpired portion of that one of such contracts which has the longest time to run.

Sec. 6. Levy of Tax for Payment of the Amount of Contract.—The amount of any contract that may be entered into pursuant to the proviisons of this article shall be assessed, levied and collected upon the taxable property in said town or district in the same manner, at the same time, and by the same officers as the town taxes, charges or expenses of said town are now assessed, levied and collected, and the same shall be paid over by the supervisor to the corporation, company, person or persons furnishing or supplying said light. If the town boards of two or more adjoining towns shall, in joint session, establish a lamp or lighting district in two or more adjoining towns, they shall determine the relative proportion of the expense of such lighting which shall be borne by each of said towns, and the amount of such expense shall be assessed and levied on the taxable property in such lighting district in each of said towns, and collected in the same manner and at the same time, and by the same officers as the town taxes or charges or expenses of the town in which said district is located are now assessed, levied and collected, and such relative expense shall be paid over by the supervisor of each of said towns to the corporation, company, person or persons furnishing or supplying said light.

Sec. 7. Lighting Contracts in Towns and Village.—Whenever a lighting district has been established lying in one or more towns, a town board has established a lighting district in a town and, thereafter, a portion of one of said towns containing a part of said lighting district shall have been included within the boundaries of an incorporated village, it shall be lawful for the town boards of said towns, said town board, and the board of trustees of said village, in joint session, without petition therefor, to jointly make, renew or extend a contract for the lighting of the whole of said village and the portion of said district not included in said village, for a period not to exceed five years. For the purpose of such joint action, in separate session a majority vote upon the same resolution at a meeting of each town board and village board, in separate session, shall be necessary. The town board of the town in which said village is located and the trustees of said village shall determine the relative proportion of the expense of lighting that portion of said district located in said town that shall be borne by such town and village if a town board and a village board of trustees in joint session shall make, renew or extend such a contract, they shall determine the relative proportion of the expense of such lighting which shall be borne by such town and such village respectively, and the amount of such expense to be borne by such town shall be assessed and levied on the taxable property in said lighting district in said town and collected in the same manner and at the same time by the same officers as town taxes, charges and expenses of such town in which a portion of said district is located are now assessed, levied and collected, and such relative expense shall be paid over by the supervisor of said town to the corporation, company, person or persons supplying or furnishing said light. The portion of the expense to be borne by said village, shall be assessed, levied and collected at the same time and in the same manner as other village charges, expenses and taxes are levied, assessed and collected and shall be paid in annual installments commencing with making, renewal or extension of said contract, to the corporation, company, person or persons furnishing or supplying said light to the amount of the contract. The expense of such lighting in such village shall not, for each fiscal year, exceed three and one-half mills on every dollar of the taxable property of said village as appears on the last preceding assessment roll before the making, renewal or extension of such a contract, unless authorized by a village election.

Sec. 8. Town Contracts for Lighting Improved Highway or Bridges.—The

town board of any town, without establishing a lamp or lighting district as provided by this article and without a petition as required by Section Two, may contract for the lighting of such improved highways or such bridges in the town outside of villages and cities, as the board deems needed for the safety or convenience of the public. Such contract shall be upon such terms and for such time or period, not exceeding five years, as the board deems proper or expedient. The amount payable annually thereunder shall be a town charge and shall be paid from the surplus money of the town, or if such surplus be insufficient, the town board may cause not exceeding one thousand dollars in any year to be assessed, levied and collected for such purpose at the same time and in the same manner as other town charges. Lighting may be contracted for pursuant to this section in addition to lighting contracted for on account of a lighting district or districts within the town.

Article II—County

Sec. 9. Lighting of Public Highways or Bridges.—The board of supervisors of any county, subject to the approval of the state commissioner of highways, may from time to time provide for lighting public highways, or portions thereof, or bridges, located in such county outside of cities and villages. The initial action of the board shall be in the form of a proposal for submission to the commissioner. The highways, or portions thereof, or bridges to be lighted, and the manner of lighting, shall be set forth in such proposal. Such proposal shall be embodied in a resolution. The lighting of one or more of such highways or portions thereof, or bridges may be proposed in a single resolution. The board may provide for such lighting if its proposal be so approved or, if modifications be suggested by the commissioner, may adopt such modifications and provide for such lighting in conformity therewith. The expense of installing, maintaining and caring for such lighting shall be a county charge, and the moneys therefor shall be provided and appropriated in the same manner as for other county expenses. The furnishing of light under this section may be provided for by contract or otherwise, but nothing herein shall be deemed to authorize the board to acquire, construct or establish a lighting plant for such purposes. The installation of lights, fixtures and connections shall be done under the supervision of the county superintendent of highways. The board may provide for the care of such lights in such manner as it may deem proper. The board may, in its discretion, at any time discontinue the lighting of any highway, or portion thereof, or bridge provided for under this section.

Article III—Villages

Sec. 1. Lighting Districts.—The board of trustees of a village shall have the power, upon application by a petition in writing of a majority of the taxpayers, resident owners of taxable real property within the boundaries of a proposed lamp or lighting district as the same appear upon the last preceding completed assessment roll, to esablish such special lighting district or districts for the proposed system of street lighting and from time to time alter or extend the same with full power to order such construction and installation and to enter into a contract for lighting in such district or districts so established or extended as said board may deem proper or expedient. Such petition shall contain a map of such district and a description of the same, and said district or districts or any extension thereof shall become established by the filing by the board of trustees of a certificate in the office of the village clerk describing the bounds of such district or districts or any extension of the same. The amount of any contract that may be entered into for such special lighting district, pursuant to the provisions of this subdivision, when established upon the petition of the property owners, shall be apportioned by the board of trustees by ordinance betwen the owners within such district and the village at large; but in no event shall said owners be charged more than the per centum specified in the application, and said amounts so apportioned to the property owners shall be assessed, levied and collected in the same manner and by the same officers as the village taxes, charges or expenses for such village are now assessed, levied and collected. The board of trustees may, on its own motion, and shall upon the petition of 25 electors qualified to vote upon a proposition, cause to be submitted at the next regular or special village election a proposition for a special lighting district or districts or any extensions thereof. When the lighting district or districts or any extensions thereof are established pursuant to a proposition submitted at any village

election, the amount of any contract entered into for such special lighting shall be assessed, levied and collected upon and between all of the taxable property in said village in the same manner and by the same officers as the village taxes, charges or expenses are now assessed, levied and collected.

Sec. 2. Board of Light Commissioners. A village, by adopting a proposition therefor at an annual election, may establish a board of light commissioners. The members of such board shall consist of three members and shall be appointed by the board of trustees for the terms of one, two and three years, respectively, and shall have all the powers and be subject to all the duties and responsibilities of such board of trustees as specified in the next eight sections.

Sec. 3. Contracts for Lighting.—The board of trustees, light commissioners, may contract, in the name of the village, with an individual or corporation, for lighting the streets, public grounds and public buildings of the village by gas, electricity or other substance; but such contract shall not be made for a longer period than ten years, nor at an expense for each fiscal year exceeding five mills on every dollar of taxable property of the village as appears on the last preceeding village assessment-roll, unless authorized at a village election. The amount of such contract shall be paid in annual installments, commencing with the date of the contract.

Sec. 4. Election for Lighting System. A proposition may be submitted at a village election for the establishment of a system for supplying the village and its inhabitants with light by any approved method, or for the acquisition of an existing private system, at an expense in either case not exceeding the sum stated in the proposition.

Sec. 5. Acquisition of Existing Private System.—If a proposition be adopted for the acquisition of an existing private lighting system, the board of trustees, light commissioners, may purchase the same at a price not exceeding the sum specified therein. If the board can not agree with the owners of the system for its purchase, proceedings may be taken to acquire the same by condemnation. If the value thereof fixed by the commissioners appointed, in the condemnation proceedings be greater than the sum specified in the proposition, such proceedings must be discontinued, unless the payment of the additional amount be authorized at a village election. If the procedings be so discontinued, the costs and disbursements of the defendants threein are a charge against the village.

Sec. 6. Establishment of Lighting System.—If a proposition to establish a lighting system be adopted, the board of trustees shall proceed to construct such system accordingly. It shall prepare a map and plans of such system, indicating the streets and localities in the village to be supplied wtih light thereby, and shall file the same in the office of the village clerk. The board of trustees, light commissioners, may acquire in the name of the village, by purchase, if it can agree with the owners, or otherwise by condemnation, any land necessary for such system. The board may amend the map and plans at any time and such amended map shall be filed in the office of the village clerk in like manner as the original. The board may construct such lighting system by contract or otherwise.

Sec. 7. Supervision and Extension of System.—The lighting system acquired or established under this article shall be under the control and supervision of the board of trustees, light commissioners. The board shall keep it in repair and shall have authority to purchase such supplies and materials as may be needed for the operation and maintenance of such system for periods not exceeding one year. Such board may, from time to time, if it has sufficient funds, extend such system, if the estimated expense of such extension will not involve the issuance of bonds or certificates of indebtedness. If the estimated expense is greater than the amount of moneys available, such extension can only be made when authorized by a proposition adopted at an election, in which event, it shall be so made. Such system may be so extended outside the village in, upon and along the highways within a town in which the village is wholly or partly situated, or within a town adjoining that in which the village is situated if the village be wholly within one town and in a county of less than one hundred thousand population provided, however, that if at the time of such extension there shall be a private electric light corporation operating within such village or within the territory into which such system shall be extended, such extension shall not be made without the permission and approval of the proper public service commission. If

such system shall be so extended outside of a village into or through a town or adjoining town or a lighting district thereof, the board of trustees, light commissioners, of the village may contract with the town board of such town for lighting the streets, highways, public buildings of such town or lighting district, in pursuance of the provisions of the town law which shall be applicable to such contract and to the levying of a tax for the payment of the amounts which shall be payable thereunder to the treasurer of the village. Wherever such system shall be so extended outside a village, occupants of premises adjacent to such extended system outside the village shall be entitled to be supplied with light therefrom under the same conditions and at the same rates as occupants of premises in the village.

Sec. 8. Ordinances.—The board of trustees, light commissioners, may adopt ordinances, not inconsistent with law, for enforcing the collection of light rents and relating to the use of light, and may enforce observance thereto by cutting off the supply of light or by the imposition of penalties.

Sec. 9. Establishment of Light Rents. The board of trustees, light commissioners, shall establish a scale of rents for the use of light, to be called "light rents," and to be paid at such times as the board may prescribe.

Sec. 10. Annual Report of Trustees, Light Commissioners.....Between the first and fourth day of March in each year, the board of trustees, light commissioners, shall file with the village clerk a report containing a statement of the following facts:

1. The amount of money on hand at the beginning of the preceding fiscal year, and the receipts from all sources during such year.

2. An itemized statement of the amount paid out during such year, and the balance on hand.

3. The outstanding indebtedness of the department, either bonded or otherwise, separately stated.

4. The estimated deficiency in the amount necessary to pay the principal or interest or the expenses of the department during the next fiscal year, after applying thereto the probable amount of light rents to be received, and any amount available from the sinking fund.

5. The improvements and extensions made during such preceding year, and the general condition of the lighting system.

6. Such other facts as the board deems important for the information of the village, together with such recommendations concerning the department as may be deemed proper.

Article IV—Cities

Sec. 1. Municipal Lighting — Cities having population not exceeding One Hundred Thousand. Special Lighting District.—The common council, in cities of the third class, or other governing body, in cities having a population not exceeding one hundred thousand, shall have the power, upon application, in writing, of the property owners, owning at least two-thirds of the number of feet fronting or abutting upon the street and along the line of any proposed improvement for the construction of an improved systemof street lighting, to establish such special lighting district or districts for the proposed system of street lighting, and from time to time may alter or extend the same, with full power to order such construction and installation and to enter into a contract for lighting in such district or districts so established or extended as they may deem proper or expedient.

The amount of any such contract that may be entered into for such special lighting, pursuant to the provisions of this act, shall be assessed, levied and collected upon and between the taxable property in said city and the district or districts respectively, in the same manner and by the same officers as city taxes, charges or expenses for said city are now assessed, levied and collected.

The common council shall, by ordinance, apportion the expenses that shall be borne by the property fronting or abutting upon the street and along the line of the proposed system or systems, and the city at large; but in no event shall the property fronting or abutting upon the street or streets along the line of the proposed system or systems be charged less than 50 per centum for such charges or expenses, nor more than the per centum specified in the application and agreed to by the property owners.

The common council, or other governing body, if the expense thereof is to be borne by the city at large, may contract for the lighting of such city with full power to order such installation and construction as may be necessary for such purpose. No contract provided for under

this section shall be for a period exceeding five years.

Sec. 2. Municipal Lighting — Cities having Population Exceeding One Hundred Thousand. Contracts for Lighting. All municipal lighting shall be supplied pursuant to contract therefor, awarded by the board of contract and supply as herein provided. Such contract shall cover and include the lighting and supplying of the lamps and the oil, gas, electric current, the cleaning, repair and renewal of the lamps and all the materials required in the use and care thereof. No bid or proposal for any such contract shall be received, nor contract awarded therefor, unless the bidder shall prior to the making of such bid or proposal, have a franchise under the authority of which the proposed contract can be performed. No contract shall be advertised for or entered into for a period exceeding five years. Each bidder shall be required to furnish with each bid or proposal a certified check, payable to the order of the city treasurer, in such sums as the board of contract and supply shall prescribe, but not less than ten thousand dollars. Such sum shall be forfeited to and become the absolute property of the city in case the bidder depositing the same shall be awarded the contract and shall not execute the same and furnish a bond for the faithful performance of such contract, in the penal sum of not less than fifty thousand dollars, within thirty days after the award of such contract. Such certified check shall be returned to the bidder, if the contract be not awarded to him, or, if awarded he shall have executed and furnished the contract and required bond.

The common council may by ordinance establish a special lighting district or districts for the purpose of ornamental street lighting, and from time to time may alter or extend the same. The board of contract and supply may contract for lighting any such district or districts so established or extended, as such board may deem proper or expedient. Any contract so entered into shall be in conformity with the provisions of this section, except that the bond to be given for the faithful performance of the contract shall be in such amount as the board of contract and supply shall determine. The amount of any contract that may be entered into for such special lighting pursuant to the provisions of this section, shall be assessed ratably upon the real property in such lighting district or districts in such manner as shall be provided by an ordinance duly adopted by the common council and approved by the board of estimate and apportionment; and such assessments shall be levied, enforced and collected upon and between the taxable property in said city and district or districts respectively, in the same manner, by the same proceedings at the same time, under the same penalties and by the same officers as the city taxes, charges or expenses of said city are now levied, enforced and collected. The common council shall, by ordinance, approved by the board of estimate and apportionment, apportion the expense that shall be borne by the taxable property in such special lighting district or districts, and the city at large; but in no event shall the taxable property in any such special lighting district or districts be charged with less than 50 per centum of such charges or expenses.

NEW PLAN TO ROUTE MOTOR TRAFFIC THROUGH CITIES

In addition to the placing of state route markers within the limits of cities, to direct motorists over the best streets through these centers of population and out again to the open highway, the Ohio division of highways and public works, under L. A. Boulay, director, has formulated a plan, which, it is hoped, will increase efficiency in routing motorists through the larger towns.

Traffic engineers for the state have not been entirely satisfied with the results of their marking in the cities. Motorists not especially alert in seeking the state's route numbers miss them. In addition, the state has not always been able to erect these signs at the most conspicuous points, due to the objections of city lot owners. In these cases the state has always done the best possible under the circumstances and has erected markers in the best available locations.

The plan for remedying this condition has not been definitely decided upon and will not be until practical experiments are made. The results of these experiments will be noted, and if they justify the present beliefs of the state traffic engineers, an improved system will be extended into all the towns in the state where population is at all dense.

Because of the highway department's headquarters being in Columbus, the ex-

periments will be made there. A small map of Columbus has been prepared showing the streets, and in heavy lines are the routes intended to be followed by the motorist who wishes to go through the town and out into the highway. All heavy lines—which are usually the main streets—have in large letters the name of the street together with the state's route number. These route markers are plainly indicated, and the map also gives the additional information of where the route leaves the city, and the names of the important towns to be reached by following that route. For instance, one desiring to go to Wilmington, Ohio, would go out West Broad Street to Central Avenue, in Columbus, turn to the left or south and follow State Route No. 3. The map shows that by following this route number one will pass through Washington C. H., Wilmington and Cincinnati, Ohio, which is the C. C. C. Highway. Accompanying this map is a list of the best routes from Columbus to various cities, it being only necessary for the motorist to follow the route number designated. By simply watching the route numbers it will be impossible for a motorist to lose his way.

This map has been furnished to each member of the traffic division of the Columbus police department. At a meeting recently the various shifts of traffic officers of Columbus were addressed by one of the state's traffic engineers, who explained how to use this map in directing motorists out of town. The state's route marking system was explained and other points of interest to the city's traffic force were discussed. According to the state's traffic experts, the plan will result in mutual benefit to the motorists and traffic officers. The Columbus officers were asked to familiarize themselves with the routes through Columbus and learn the names of the most important towns on each route. By this plan the state hopes materially to increase efficiency in directing traffic through towns.

Traffic officers in Columbus, with the maps the state has furnished to them, are now better equipped to direct the out-of-town traveler. Once on the highway the motorist can not get lost if he follows the pressed steel route marker plates already erected along the road. They are yellow and black, in the shape of the outline of Ohio. Through towns these are mounted on angle irons, and in the business section on street lighting poles.

THE MOTORIZATION OF STREET CLEANING AND REFUSE REMOVAL IN CHICAGO

By William J. Galligan, Assistant Superintendent of Streets, Chicago, Ill.

The motorization of the equipment of the Chicago Bureau of Streets in street cleaning and refuse removal will be grasped more readily if the city's size and mileage are fully realized.

Chicago has a population of over 2,900,000; an area of 200 square miles—20 miles in length, 10 miles in width. It has 2,300 miles of paved streets, 1,050 of unimproved; 450 miles of paved alleys, 1,350 of unimproved—a total of 5,150 miles of streets and alleys. It has 1,350 miles of street railways, with a daily passenger traffic of over 3,050,000.

Street Cleaning Problem Has Changed

In common with that of other cities, Chicago's street cleaning problem has greatly changed during the past 14 years. In 1911 the city's license bureau showed 73,226 horses and 13,944 motor vehicles, as against 26,321 horses and 296,441 motor vehicles at the present time. It is not, therefore, so much a problem of the removal of heavy dirt as of an opportunity for cleaning the streets at all.

Much time and intense study are given to the regulation of automobile traffic. Stringent ordinances and laws are passed in an attempt to safeguard human life, facilitate travel, and promote the interests of the business public.

As automobile traffic increases, street cleaning in like ratio becomes more difficult and increasingly greater in cost. Seventy-five percent of street dirt on the pavement finds its way to the gutters within a few hours. The demand for clean streets and the removal of snow constantly grows more insistent, but with all the thought and care given to traffic regulations, no consideration has been taken of the increased difficulty of street cleaning. If this branch of service is to continue to function, regulations must be made furnishing it the opportunity.

The motorization here presented includes flushers and sweepers; tractors, trailers, and "caterpillars"; snow plaws and loaders.

Flushers

Flushers are used to supplement the work of the cleaning forces by washing the dust and fine dirt from the pavements. The downtown or "Loop" streets and those of the congested districts are flushed nightly. The main thoroughfares,

business and traffic residental streets are flused tri-weekly, others less frequently.

The city has 28 5-ton flushers of 1,500 gals. capacity; 7 Mack trucks equipped with Hvass single flushing unit, purchased at a cost of $9,000 each; 1 Packard with Studebaker model double unit, $7,580; and 20 Super trucks with Studebaker double unit, 10 bought in 1922 at $7,500 each, 10 in 1923 at $6,955 each. The life of a flusher is estimated at 100,000 miles, and is discounted from year to year on basis of mileage travelled.

Twenty-six of the flushers are operated in double shifts of eight hours each; between 12:30 p. m. and 6:30 a. m. The remaining two are held in reserve to replace any that may be temporarily out of commission. Fifty-two crews of chauffeur and helper each are required to man the 26 flushers in daily use. Chauffeurs receive $7.50 per eight-hour shift, helpers, $6. These 26 flushers travel 1,104 lineal miles and flush 11,925,296 sq. yds. daily.

The Mack single unit averages 18 lineal miles per shift, consuming 2 quarts of oil at 12 cents per quart and 12 gals. of gasoline at 15¼ cents per gal., making a cost of $2.07 for oil and gasoline. The Packard and Super double unit average 22 lineal miles per shift, consuming 2 quarts of oil at 12 cents per quart and 15 gals. of gasoline at 15¼ cents per gal., making a cost of $2.53 for oil and gasoline. All models operate with 40 lbs. pressure directed on the stream. For the year 1923 the cost of operation of the Mack single unit, including oil, gasoline, grease shop, labor, parts, tires, depreciation, chauffeurs and helpers, averaged $1.17 per lineal mile; that of the Packard and Super double unit 88 cts. per lineal mile. The cost per 1,000 sq. yds. was 8 2/5 cts.

It has been ascertained through observation and accurately kept records that the double unit not only gives better results in operation because of ability to control the stream regardless of the speed of the truck, but also in point of economy is to be preferred; the double unit flushing on an average four more lineal miles of pavement to a shift than the single, with only three more gallons of gasoline; and using 30 tanks of water, as against 28 with the single. The single unit run on second speed when flushing; the double unit on high speed.

On car-line streets 50-ft. width or less, one trip is made on each half of the street. On the first, which includes the center between the innermost car tracks, three nozzles are used on the single unit type, and two on that of the double; on the return trip two nozzles are used on both models. On residential streets the full width of the pavement is flushed in one operation.

On the flushers of the single unit the four nozzles are trained to the right of the direction travelled, good results not being obtained otherwise. On those of the double unit the nozzles are arranged to flush on either side of the street or both sides in one operation.

If the present plan is carried out, 22 flushers will be added during the coming twoyears, making 50 in all. This number will be sufficient to care for the city's needs in this respect.

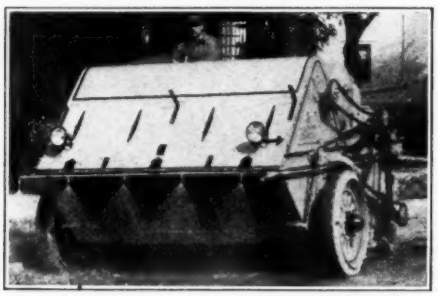
TYPE OF TRACTOR TRUCK (MACK) AND TRAILER USED IN ASH COLLECTION SERVICE IN CHICAGO

Sweepers

Chicago has 11 Elgin Motor Sweepers. Ten are used daily and one kept in reserve for emergency. They are used for the most part in the outlying wards where they are less liable to be handicapped by parking of automobiles. The machines spray, clean the gutter, sweep the street, and pick up the dirt in a single operation. They average five hopper loads of dirt of 2¾ cu. yds. each, consuming 10

gals. of gasoline and 2 quarts of oil in an 8-hour shift. The machine has a speed of six miles per hour. The rotary broom has two speeds. For heavy work the machine is operated in "second" speed and the broom in "fast," with a maximum flow of water. For light sweeping the machine is operated in "high" speed and the broom in "slow."

Due to our immigration laws which restrict the class of labor who sought and were adapted for this service, there has resulted a growing scarcity of good, available men and a greatly increased rate of wages. Realizing, therefore, that cities would be forced to seek other and more efficient methods, Chicago has been a pioneer in adopting mechanical equipment for street cleaning. This city purchased in 1915 the first Elgin motor pick-up sweeper. It has long felt that manufacturers who constantly strive to perfect



TYPE OF STREET SWEEPER (ELGIN) USED IN CHICAGO

their peculiar lines of equipment should be encouraged by those for whose interest they are manufactured. For the past 10 years the Elgin representatives have devoted their shop solely to the developing and perfecting of their street sweeper. They have succeeded in making a machine which performs its various functions with utmost satisfaction.

Tractors and Trailers

The motorization of Chicago's refuse collection equipment was begun in 1922. During the preceding years, the inadequacy of the city's method of collection in dilapidated wagons, the excessive cost of refuse removal by hired trucks, the increasing distance of dumps, and advancing cost of operation led the City Council and Street Bureau officials to seek an improved system. They investigated the use of the tractor and trailer system in other cities and were convinced that this would give satisfactory service at less expense. They therefore made appropriation for partial installation of this system. As these vehicles were for an entirely different activity from those previously used, the Council departed from its established policy of standardization and authorized the purchase of one 5-ton truck from each of the following companies:

Kelly Springfield Motor Truck Co.	$ 4,414.60
Illinois Auto Truck Co. (Super)	4,800.00
Packard Truck Co.	4,836.70
International Harvester Co.	5,092.00
Garford Motor Truck Co.	5,307.00
The White Company	5,768.39
H. Paulman & Co. (Pierce-Arrow)	5,913.83
International Motor Co. (Mack)	6,224.73
	$42,357.25

In this way the city would be afforded opportunity for experimenting and deciding which tractor was adapted to its needs.

Likewise in the selection of trailers, several types were chosen, as follows:

	Each	
6 Detroit (knuckle type) reversible trailers	1,745.00	20,940.00
12 Troy (knuckle type) reversibel trailers	1,745.00	20,940.00
21 Highway (knuckle type) reversible trailers	1,595.00	33,495.00
6 Trailmobile (knuckle type) reversible trailers 3 @ $1,238.00; 3@	1,438.00	8,028.00
18 Warner (wagon type) non-reversible trailers	1,617.50	29,115.00
6 Automotive (wagon type) non-reversible trailers	1,450.00	8,700.00
12 Hvass (wagon type) non-reversible trailers	1,725.00	20 700.00
		$130,272.00

Since the installation of the trial trailers purchased during the summer of 1922, foremen of dumps, superintendents of collection and equipment, engineers and officials of the bureau have made careful investigation of their operation and efficiency as contrasted with the old method of team and motor truck haul. Reports from all are favorable to the tractor and trailer system. Their investigations have convinced them that two types of trailers are adapted to Chicago's needs, namely, Highway Trailer Company's and Albright & Company's Warner 5th wheel non-reversible, 4½ yd. water-level. These trailers are built on correct principles. They travel straight in train, are sufficiently light, yet strong and durable in collection of refuse in unpaved alleys, stand the severe test of soft, wet dumps, and seldom need repair. In accord with this finding, 80 of the Highway at $1,595 each, and 79 of the Warner at $1,535 each, were purchased at a cost of $248,865.

As no appropriation was made for the purchase of tractor trucks and the city was hiring trucks at the rate of $32.50 per day, the International Motor Company proposed furnishing them on a rental plan, and that when an amount equal to the cost price of the truck had been paid, the equipment would become the property of the City of Chicago.

This plan was accepted, and 25 Mack trucks were placed in service in August, 1924, to be paid for on the deferred payment plan, of $400 per month for each truck; payments to be continued until $6,100 per truck is reached.

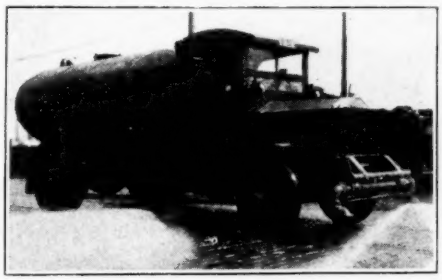
The initial installation of the tractor and trailer system was made in 6 of the 50 wards into which the city is divided, one on the south side, two on the west and three on the north. Four of the wards were selected because their respective ash and refuse teams were unable to make but one load a day, the dumps available for disposal being from eight to nine miles distant. This made the cost of collection almost prohibitive. In the case of two wards chosen for experimental purposes on short hauls, the distance to their respective dumps were three and five miles.

There are in the six wards, eight tractor and trailer units, one tractor and three trailers in active operation, forming a unit or train. To each unit there are three, and in certain wards six, trailers in reserve in order that collection may not be interrupted while tractor and train are in transition.

The tractor-trailer trains make from five to six trips on the 3-mile haul, four trips on the 5-mile, and three on the 8- or 9-mile haul, travelling in the last instance a total mileage of from 48 to 54 miles daily. The tractor picks up the trailers from their collection districts or from a central point to which the trailers have been brought for that purpose. Where conditions permit, the tractor hauls the trailers into the dump, but where this is impossible by reason of boglike condition, "caterpillars" bring them in. The tractors are manned by a chauffeur and conductor or helper. The trailers are horse-drawn, manned by a driver and helper and operated in specific districts. Three to five loads are collected daily. The trailers have a water level capacity of 4½ cu. yds. The loads are heaped and receive a credit of 6 cu. yds. at the dump. The engineers state that they carry more nearly 7 than 6 cu. yds.

While a statement showing standardized costs of operation, maintenance, and repairs can not yet be made, it can be reliably stated that the unit cost of collection and disposal is materially lower than by any other method employed to date.

Based upon the test of the past year with 8 tractors and 81 trailers, the city officials and engineers estimate that 142 tractors and 1,020 trailers are needed to cover the area within the city limits. The cost of these vehicles is placed at $2,342,000. Supplementing them, the city would still employ 452 teams to collect from the unimproved alleys of the city. With that equipment, it is estimated that a large saving would be effected. As previously stated, the city is purchasing 25 tractors and 159 trailers, and it is desired to install the complete service.



TYPE OF FLUSHER USED IN CHICAGO

Last year the collection of ashes and refuse cost $2,570,190 and the hauling of garbage $638,125—a total of $3,208,313. It is estimated that the same service in quantity but considerably better in character could have ben rendered by the tractors and trailers for $2,490,810, thereby effecting a saving of $717,503. From this estimated annual saving of $717,503 alone all the tractors and trailers required could be paid for in about three years.

Caterpillar Tractors

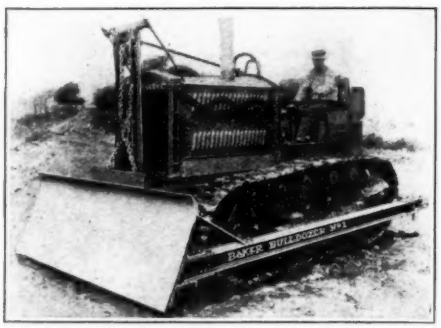
The use of the "caterpillar" on the city dumps began in an experimental way. An appliance unique to Chicago, termed a "bulldozer," had been used in pushing ashes and refuse over the edge of abandoned stone quarries and reclaimed land along the lake front. The appliance was in the nature of a road scraper projected at the end of a long pole, balanced on a two-wheel axle. A team was hooked to the whippletree and when driven pushed the refuse in front of the scraper into the fill.

The "caterpillars" were tried in place of horses: First a 2¾ ton which was

increased to a 5-, then to a 10-ton. It was found to be necessary frequently to pull mired, loaded trucks out of the mud, requiring additional reserve power. The 10-ton "caterpillar" tractor was found to meet all requirements and was adopted as standard. The "caterpillar" tractors are also used in pulling trailer trains into dumps when dump roadways are soft and wet. The city now has one 2½-ton Cleveland, five 5-ton Holt, and three 10-ton Holt tractors. The 10-ton "caterpillar" tractors consume 23 gals. of gasoline and 4 quarts of oil, each, in an 8-hour shift.

Snow Removal

The territory covered in snow removal comprises the congested downtown business region or "Loop"; the wholesale, warehouse, market and commission house district; railway terminals, and the main arteries and car-line streets leading to the "Loop." It includes also the principal streets of practically all the business centers of the 50 wards into which the city is divided, each of which in area and population is a city in itself. Along the street railway of the city where the snow is not cleared from the pavements, it is removed to the extent of 50 ft. where passengers get on and off, and from the entire intersection at prominent transfer points. Attention is also given to the removal of snow from in front of churches, schools, and buildings generally where persons gather in large numbers. Newspapers are scanned for burial notices so that snow may be removed from places where funerals will take place.



HOLT TRACTOR EQUIPPED WITH BAKER BULL-DOZER USED TO LEVEL WASTE DUMPS IN CHICAGO

Since the winter of 1918, which in snowfall and severity, broke all records for the Chicago region during the existence of the weather bureau, the fall of snow has been greatly below normal. The depth of fall for the past winter, 1923-24, was 26.9 inches.

The mechanical equipment used in snow removal are plows, trucks, and loaders. The snow is disposed of along the river front, in large seyers, and vacant lots.

The Bureau of Streets has 50 snow plows of the Champion, Good Roads, and Baker makes. These are attached to the front of its street flushers. They are started when the snow has reached a depth of about 1½ ins. and operated continuously thereafter until the streets included in the schedules are cleared. This places the snow in windrows ready for removal during and after the cessation of the storm. The plows clear the pavements of many through streets for traffic, the environment of which does not require its removal. They are operated in batteries of two, and travel at two speeds, from four to six miles per hour.

The snow is removed by trucks, hired from contractors and firms at the rate of $32.50 per day of eight hours. The trucks are loaded by hand; by the Barber-Greene Company snow loaders, and by clamshell derricks mounted on trucks.

Snow Loaders

Only once during the past winter was there sufficient snow at any time to make the use of the Barber-Greene loaders practicable, and this snow falling in a mild temperature making it nearly slush, followed by a zero drop in temperature, did not furnish a favorable condition for their operation. In December, 1920, Chicago made an initial test of the first snow loader in the country—the Barber-Greene. It ran 32 hours continuously without a breakdown. It averaged more than 3 cu. yds. per minute, although the snow had not been plowed nor piled. In its operation a loader requires the services of an engineer and a helper, and two laborers at the plow end. It is self-propelled, self-loading, and end-discharging. It has a plow on either side of the conveyor belt, gathers the snow from the pavement and places it on the conveyor, which loads it on to a truck moving in the rear of the loader. It is operated by a Buda gas engine which consumes less than 12 gals. of gasoline and about a quart of oil in an 8-hour shift. The city has four of these, bought at a cost of $4,900 each.

The clamshell derricks proved of value during the past winter, loading an 8-yd. truck in about three minutes. They are operated by a separate motor from that

of the truck. Six of these were employed, being hired from a contractor at the rate of $5 per hour.

The congestion of the streets is a great hindrance to the use of mechanical loaders, the hours from midnight and early morning being the only time when they are comparatively free from traffic and parkings. As these are the hours when it is practically impossible to secure labor and yet when conditions are most favorable for removal, the loaders have exceptional value. Under favorable conditions there is great economy in the use of mechanical loaders over that of laborers with scoops.

Extent and Cost of Removal

During the period from January to the end of March, 1924, 55,889,487 sq. yds. of pavement were cleared, 311,969 cu. yds. of snow being removed. The cost of removal, including labor and motor vehicles, was $306,724; the cost of cartage being 34.4 cts. per cu. yd.

The foregoing paper by Mr. Galligan was presented at the recent annual meeting of the American Society for Municipal Improvements.

RULES OF THE ROAD AND HOW TO ENFORCE THEM TO INCREASE SAFETY

By T. H. Carrow, Supervisor of Safety, Insurance Department, Pennsylvania Railroad

Seventeen thousand persons were killed and many times this number were injured in motor vehicle accidents in the United States in 1923. These figures in a general way indicate the extent of the highway accident problem in the country as a whole.

The subject: Rules of the Road and How to Enforce Them, will be treated under three heads as follows:

First: The way automobiles are operated on the highways to show the reasons for the large number of accidents.

Second: Methods that have been successfully employed to prevent accidents.

Third: Recommendations.

In order that attention may be concentrated on practical measures it will be well first to enumerate some of the things that are desirable but can not immediately be done.

General Grade Separation Not Feasible

It is impossible, for example, to increase on a large scale the width of the highways that are now considered too narrow, because the necessary funds are not available. There are a great many dangerous curves in the roads throughout the state that should be eliminated which will also have to be deferred because of lack of funds. There are 40,000 miles of surfaced roads in Indiana and 37,000 miles that are not surfaced. The citizens living along the roads that are not improved are anxious to have their roads surfaced and while the authorities are anxious to deal impartially with all sections, it is impossible to improve all the roads at once, or to make the improvements more rapidly than financial conditions will permit.

The highways cross the railroad tracks at grade at hundreds of places in the State of Indiana and as elimination costs on the average of $75,000 per crossing it is obvious that crossing elimination on a large scale is out of the question. To eliminate all the crossings in the country would cost $19,000,000,000 and a fairly large percentage of the crossings are in Indiana. All of these improvements are highly to be desired, but in view of the lack of funds and the tax rate which is already high, progress in this direction is decidedly limited.

It is a consolation, however, to know that there is not a dangerous physical condition on the highways of the state, so far as the operation of automobiles is concerned, that can not be warded against by the observance of rules of the road and reasonable precautions on the part of automobile drivers. It is to this end I think our efforts to prevent highway accidents should be primarily directed and if we establish the facts in the matter the necessary action will be suggested as a matter of course.

Last summer checks of reckless driving of automobiles were made at highway crossings in every one of the 13 states traversed by the Pennsylvania Railroad System, a total of 114,257 cars having been observed, of this number approximately 3 percent were driven in a careless or reckless manner, while 97 percent of the drivers displayed reasonable care. At a few crossings the percentage of reckless drivers was much higher than the average.

For example, at one crossing not so far from the capital of Indiana, during a period of nine hours 950 automobiles were checked of which number 167 were estimated to have averaged a speed of 47 miles per hour when crossing over the railroad tracks. In two instances the

speed reached 70 miles per hour; 10 cars were being driven 65 miles per hour and in 11 cases the speed was 60 miles per hour.

The Careless Three Percent

The performance of the careless 3 percent of drivers is shown by the following notations on the reports of inspectors.

Driver ran around two cars stopped at crossing for approaching train.

Driver passed over crossing ahead of approaching train after watchman had taken his position and displayed stop sign.

Driver attempted to pass car ahead and was nearly crowded into ditch.

Driver disregarded approaching train; gave watchman the laugh.

Bakery truck racing with a touring car; both cars passed over crossing same time.

Small boy about 10 years of age driving 25 miles per hour.

Driver paying too much attention to a young lady on the front seat, almost ran off the side of road.

Driver has no use of legs and to apply brake or clutch, forces weight of body against pedals by pulling on stearing wheel.

Changed gears on track, car stalled.

Two men in a roadster, both intoxicated.

Excessive speed—nearly upset on main track.

The check made of reckless driving fit in with the analyses that have been made from time to time of highway crossing accidents.

A Study of Crossing Accidents

During a period of four months there were 682 crossing accidents on the Pennsylvania Railroad System, resulting in 90 fatalities and 150 injuries, classified as follows:

Four hundred and eighty-seven accidents occurred in broad daylight and 195 at night, from which the inference may reasonably be drawn that the inability to see the railroad in the distance is not so much a factor in highway crossing accidents as failure on the part of auto drivers and others to make careful observation to see where they are going.

Approximately 60 percent of all the trains involved were running less than 20 miles per hour, indicating that the failure of auto drivers to keep a constant lookout ahead and have their cars under control, is a greater factor in crossing accidents than the speed of the trains.

Seven fatalities and 17 injuries were due to the drivers of automobiles attempting to beat trains running at various speeds over the crossings.

Fourteen fatalities and 7 injuries occurred at crossings where crossing bells were in order and ringing at the time the automobiles were drivenin front of the trains.

Forty-nine auto drivers disregarded the warning or signal of crossing watchman to stop, with the result that 5 persons were killed and 22 injured from this cause.

Sixteen accidents were attributable to defective automobile brakes and it is probable that in many other instances this was the indirect cause.

The brakes on locomotives, passenger cars and even freight cars are thoroughly inspected every time they move from one terminal to another, but the brakes on many automobiles and trucks, which run at high speed on the streets and highways are rarely, if ever, inspected, and it is probable that a systematic check by the highway departments of the several states to detect defective foot and emergency automobile brakes would disclose a startling situation. During the month of January, 1923, the Police Department of the City of New York made an inspection of approximately 4,000 cars and found 800 with defective brakes. In 142 of these cases both brakes were inoperative and the drivers were arrested and convicted.

Seven accidents, resulting in three fatalities and three injuries, during the four months' period were attributable to drivers of automobiles being intoxicated. The number of other cases due to this cause that were not detected on account of the drivers being killed can not be determined.

Sixty-one accidents resulting in six deaths and 12 injuries were due to automobiles stalling on tracks. Inexperienced or incompetent drivers were evidently involved in the majority of these cases.

There were 280 cases of automobiles running through or into crossing gates and 70 cases of automobiles running into the side of trains.

Safety of Railway Travel

Now, let us compare the performance of automobile drivers with locomotive enginemen and other railroad employes. Many of the large railroads of the country frequently operate several successive years without a passenger being killed in train accident. The Chesapeake and Ohio Railroad, for example, recently completed nine years without a passenger being

killed from this cause. Not so long ago a bulletin was issued by the Pennsylvania Railroad System which stated that during a year in which 1,400,000 passenger trains were operated and 152,000,000 passengers were carried not a single passenger was killed in train accident and it is interesting to notice this record was made without the aid of automatic train control which would cost $115,000,000 to install on the Pennsylvania Railroad System alone, while it is estimated that such installation on every foot of the railroads of the United States would save only a negligible number of accidents. It is obvious that the expenditure of even a small proportion of the amount of money that would be required for automatic train control toward elimination of crossings and providing warning signals at crossings where elimination is impossible would result in the saving of a great many more accidents than would be prevented by automatic train control.

What is the explanation of the success achieved by the railroads along safety lines? Simply this: The railroads have adopted a comprehensive set of operating rules; the employes are properly trained and examined on these rules and constant supervision and checks are provided to see that the rules are observed.

On every division of every railroad there is at least one man assigned to making tests and observations to detect violations of rules and regulations in addition to the checks and observations made by supervisory officers.

During the month of August last, 184,911 tests and observations were made on the Eastern Region of the Pennsylvania Railroad System alone which showed a 99.89 percent perfect performance and for every violation of the rules or regulations the employes found guilty were held as responsible as if an accident had resulted, and penalties fitting the violations were imposed.

The experience in marine transportation is similar to the experience of the railroads. The boats operated by the Philadelphia and Camden Ferry Company for example are constantly crossing the Delaware River; avoiding traffic going up and down the river and finding their way into slips the exact width of the vessel. During the year 1923 these boats made 300,000 trips in fog, rain, storm and fair weather, and transported 40,000,000 passengers and 3,000,000 vehicles with but one minor collision for which the master of the boat was responsible.

Conclusion

We have now clearly established, as we set out to do, the primary reasons for the large number of highway accidents, namely, the carelessness, often of a criminal nature, and violations of the Rules of the Road on the part of 3 percent of automobile drivers.

We have also shown that the railroads have been successful in the prevention of accidents by systematic supervision and checking to see that rules are observed and rigid discipline to secure their enforcement and by logical inference it is concluded that the methods employed by the railroads, in modified form, may be applied on the highways.

It is therefore recommended as the first step in a state-wide highway accident prevention program that three or more persons especially qualified for the purpose be engaged to make an exhaustive study of the highway accident situation in the State of Indiana, the rules of the road and laws relating thereto and methods of public safety education with the view of making recommendations to be submitted to the proper authorities for action in the premises, the recommendations to be accompanied by necessary supporting data and presented under the following heads:

1. Highway Accident Statistics

(a) Requirements for reporting highway accidents. (Both parties involved in an accident to report.)

(b) Number of accidents classified by causes and locations.

2. Rules of the Road and Laws Relating Thereto

(a) At present in effect in Indiana and other states.

(b) Necessary revision and additions.

(c) Abridged and simplified edition of rules of the road and laws relating thereto for general use.

(The rules of the road as embodied in the law are unintelligible to the average reader.)

3. Officers of the Law

(a) Number at present temporarily or permanently assigned to checking violation of the motor vehicle and highway laws, that is, Rules of the Road.

(b) The extent of checking necessary to secure enforcement, the methods of checking to be employed, the number of officers required to make the checks and how they shall be provided.

(It is suggested that consideration be given to periodical state-wide checks by 500 or more regular or special officers.)

(c) Monthly tabulations of the checks and arrests made for the use of highway officers and publicity purposes.

4. Safety Education

(a) Schools.

(b) Public press.

(c) Signs, placards and posters.

(d) Examination of drivers of automobiles on rules of the road, the meaning of warning signs, safe practices and skill in operation.

5. Provisions for Changing or Modifying the Rules of the Road

(The law should provide for the proper authorities to make necessary changes in or additions to the rules of the road without legislative enactment.)

6. Physical Conditions

(a) Signs on the road and markings on the road.

(b) Designation of extra hazardous railroad-highway crossings.

(c) Speed restrictions at railroad-highway crossings, on curves, at intersections, etc.

(d) Consolidation of two or more crossings when one will serve the purpose.

7. Budget

(a) Estimated cost of enforcing the rules of the road in the manner recommended.

(b) Sources from which the necessary funds may be obtained.

The foregoing paper by Mr. Carrow was presented before Indiana's First Grade Crossing Safety Conference, at Indianapolis, Oct. 14, 1924.

MODEL INCINERATOR SPECIFICATIONS AND CONTRACT TESTS

(Editor's Note: Following is a symposium by the members of the Committee on Garbage and Refuse Disposal of the Sanitary Engineering Section of the American Public Health Association and by other engineers. It was presented to the annual convention of the A. P. H. A. at Detroit, Oct. 23, 1924. The Committee membership is as follows: C. M. Baker, State Sanitary Engineer, Michigan Board of Health, Lansing, Mich.; M. N. Baker, Associate Editor "Engineering News-Record," New York City, Chairman; Samuel A. Greeley, Consulting Engineer, Chicago, Ill.; C. A. Holmquist, Director, Division of Sanitation, New York State Department of Health, Albany, N. Y.; I. S. Osborn, Consulting Engineer, Vice-President C. O. Bartlett & Snow Co., Cleveland, Ohio. Other participants in the symposium are as follows (all are consulting engineers except where official municipal engineering connection is given): F. A. Barbour, Boston, Mass.; Harrison P. Eddy, Boston; Guy C. Emerson, Consulting Engineer, Boston Finance Commission; James H. Fuertes, New York; George W. Fuller, New York; Prof. John H. Gregory, Johns Hopkins University, Baltimore; T. Chalkey Hatton, Chief Engineer Milwaukee Sewerage Commission; J. A. Jensen, Supervisor Water Works, Minneapolis (entrusted by the city government with the question of incineration); M. M. O'Shaughnessy, City Engineer, San Francisco; Steuart Purcell, Chief Engineer Department of Public Improvements, Baltimore, Md.)

The attention of your committee during the past year has been centered in the possibility of framing general specifications together with contract guarantee and test requirements for incinerators. This temporary delimination of the possible field work for the committee was suggested by one of its members, C. M. Baker.

Opinions on the subject were requested from : (1) members of the committee, and, (2) other sanitary engineers, either in private practice or municipal employ. The results of the inquiry, assembled by the chairman of the committee, are here presented as a symposium. By way of general summary, the chairman feels warranted in drawing the conclusion that although some members of the committee and a considerable number of the other engineers interrogated, seriously question the possibility of what is commonly known as a standard specification—owing largely to variations in conditions to be met in various localities and to the general state of the art—yet the consensus of opinion sems to be that something of the kind would be useful and to warrant the hope that at least a general outline for Model Incinerator Specifications and Contract Tests could be formulated. The symposium is submitted to the Sanitary Section for additional discussion and, if considered desirable, an expression of the wishes of the section as to further action by the committee.

Opinions From Committee Members

C. M. Baker—In my official capacity numerous inquiries come to me from municipalities regarding the merits of different methods of garbage disposal. I, of course, realize that each question is

usually a problem in itself the solution of which depends largely upon local conditions. Nevertheless I believe that certain definite general standards should be adopted that would be of material assistance and guidance to municipalities in adopting plans for garbage and refuse disposal.

In some cases, particularly for smaller municipalities, where conditions are not favorable to sanitary fills and where reduction would not be practicable, incineration is probably applicable. Standard specifications for incinerators would, therefore, be of material value to these communities. I do not mean detailed specifications, but other simple general specifications, together with an outline of standard tests, the whole designed more particularly to meet the needs of the smaller municipalities.

There is probably no branch of sanitary engineering that is in such chaotic condition as that of garbage and refuse disposal. It has been a political football in practically every municipality but is not this because engineers have not specifically and forcefully pointed it out as an engineering problem? Would not standard requirements, officially adopted by the A. P. H. A., give the engineer an official standing in this field?

M. N. Baker—I have long been impressed with the loose character of most incinerator specifications, contract guarantees and acceptance test requirements. I think all our cities should, as a few of them do, employ a competent engineer to design proposed garbage and refuse disposal plants, of whatever type, to draw specifications and contract forms, and to supervise and report on acceptance tests. Where it is thought desirable to permit contractors, whether manufacturers or general contractors, to submit their own detailed plans, specifications and guarantees it is essential, if the bids are to be comparable, that they conform to a general scheme of requirements. Such a general scheme would also be helpful even where an engineer is engaged to draw detailed plans and specifications.

Samuel A. Greeley—1. Plans for incinerators have so far been developed largely as patented processes in the hands of certain manufacturers and promoters and there has been little basis for defining the work to be done in specifications. In this way the first step in the development has been the actual purchase of incinerators under guarantees, and advertisements for bids have stated only the capacity desired and, in some cases, the height of the chimney. Manufacturers have offered their own guarantees.

2. As a second step, cities undertook to get bids on a somewhat more comparable basis by outlining a uniform guarantee on which all manufacturers should bid, including also specifications of the materials to be used, together, in some cases, with a general outline plan. This has perhaps been the usual method in the larger projects.

3. A development of recent years has been for the city to buy the rights to a certain type of incinerator which, after due consideration, they have selected as the best, and then to secure from the manufacturer plans and specifications on which competitive bids can be taken for erection. This, for instance, was done at New Orleans in connection with the construction of incinerators, as I understand it. I think New York has recently purchased incinerators without competitive bids or with competitive bids much as they might do in buying a boiler or a chimney or the like. All other parts of the plant were built under competitive bids based on plans and specifications prepared by the city's engineers. This would relegate the incinerator to its proper importance on a cost basis with the plant as a whole and perhaps might reduce the temptation for political interference. Under this method, more disinterested engineering effort is permissible than under (1) and (2).

4. A further movement, not yet far advanced in this country, is preparation, by the city's engineers, of plans and specifications for the entire project, followed by taking bids for construction. I do not know whether this has been done much in England but I think it has been done in Germany in some of the larger installations.

It seems to me there is some analogy between this situation and that of the development of water filtration plants. A number of years ago, filter plant installation was in the hands of manufacturers and promoters having patented devices, and plants were sold with little engineering competition, and in some cases under guarantees, some of which I think were rather absurd. Later on, engineers began to make detailed designs for all parts of the filter plant except the filter equipment. Now it is the practice to make detailed designs for all parts so that any competent contractor can figure.

This at least is our practice so far as the strainer system, pipe gallery, and the like are concerned. We do not detail the rate controllers or loss-of-head gages, but buy them much as we would also buy the hardware, cement and other standard products. I think very much better filter plant design has resulted from this practice.

I do not know that we are ready at the present time to go much beyond (1) above, but I think a furnace type might be selected as such with less controversy than the selection of an entire plant. I think the cost of the furnace above would be not much over a third that of the entire plant. It might be possible in this way to make up a general outline plan and specification and ask for proposals of type of furnace with only an indication as to cost. An engineer could then select the type of furnace and prepare plans and specifications for the entire project on which bids for construction could be taken.

It does not seem to me that a standard specification can be worked out because after all it is the element of judgment based on experience that is mainly needed and a standard specification would discourage rather than promote this.

It should not be difficult to get together an outline of garbage plant specifications, including guarantees and tests, and in the present stage of development this would probably be very helpful. In a way it does not get at the root of the matter, which comes down to items of plant location, general arrangement of buildings and detailed designs of furnace work. Perhaps some general recommendations on methods of procedure with reference to engineering work would be helpful along this line.

C. A. Holmquist—It appears to me that it would be impracticable if not impossible, for our committee in one year to go into the entire question of collection and disposal of refuse in detail and that it would be advisable to confine ourselves to one subject, such as that suggested by Mr. Baker of Wisconsin, developing standard specifications for incinerators, which could probably be done in one or at least two years. On the other hand, it might be valuable to cover in general The Collection and Disposal of Refuse and Garbage for Smaller Communities, say less than 25,000, pointing out the advantages and disadvantages of various systems of collection and disposal.

I. S. Osborn—With the large number of different opinions in connection with incinerator work, no doubt any specifications which were prepared by the committee would necessarily be more or less general. The conditions vary in cities as to the quality and quantity of refuse to be incinerated, so that a furnace designed to meet one set of conditions might be undesirable under another.

If there is any way the committee can outline general policies to be followed whereby the municipal official will be somewhat safeguarded and assured of securing equipment that will satisfactorily meet these conditions, it would be well worth while.

In many cases I have found that specifications did not have much bearing on the final selection that is made, as the decision often rests with a council committee the members of which become (to their way of thinking) well educated in furnace designs, or with the salesman who is the most adept in presenting his proposition or has done the most extensive preliminary work through political influence previous to the preparing of specifications or the awarding of contract.

Opinions from Other Sanitary Engineers

F. A. Barbour—In my opinion it might be possible to develop a specification—largely general in its requirements, but with more or less particular definition of certain necessary phases—which would serve a good purpose. It would, in my judgment, be impossible to prepare standard specifications to cover all necessary requirements in any particular case: there would be danger that municipalities would accept such standard specifications as sufficient without adaptation to local conditions by a competent engineer.

Specifications defining the character of the refuse to be burned, requiring a guarantee of performance based on the consumption of so many units of fuel per ton of refuse burned to satisfactory ash, with a test extending over a sufficient length of time to express the results, might be productive of good. A further guarantee of the labor hours required per ton of refuse and a requirement that the contractor shall be responsible for six months for any parts shown to be defective within such period, with a retention of a small percentage of the contract price, might also be of value.

In brief, it would be my idea that the contract form should be similar to that used in contracts for pumping machinery—setting forth general requirements, stipulating the fulfillment of certain guar-

anteed efficiencies and economics, and allowing the contractor under these general requirements to submit his own detailed specifications, which would be made part of the contract with the successful bidder.

Harrison P. Eddy—It is my opinion that general specifications can properly be prepared.

Guy C. Emerson—My first thoughts are that it is a matter of rather doubtful feasibility.

George W. Fuller—I doubt if your committee could materially advance municipal sanitation by going into this technical phase of garbage disposal. The effort would be misunderstood and abused, I am afraid, by non-technical officials and would perhaps hinder technical advisers of municipalities who would naturally desire to fit their specifications to local conditions, which vary materially from place to place.

Prof. John H. Gregory—I think it would be highly desirable if such a specification could be prepared. I won't say that it would not be possible but I feel that it might be difficult. For example, is the incinerator to burn mixed refuse, and if so what percentage of ashes; or is it to burn a mixture of garbage and rubbish, either wrapped or unwrapped? How is the material to be charged into the furnaces? And how would you prepare a standard specification which would permit of competitive bidding on the ———— incinerator such as was installed at ———— and also on a ———— incinerator? I raise these questions merely to show that a standard specification might require a number of alternative paragraphs to meet local conditions. I think it would be well worth while for your committee to attempt a tentative specification.

T. Chalkley Hatton—For many years I have felt that the collection and disposal of garbage, especially the latter, is as much an engineering problem as is the disposal of sewage, and one which should not continue in the hands of the promoter, who has made such a mess of it. Garbage, like sewage, is complex in character and its character should be studied scientifically to the end that the proper type of apparatus for its successful disposition may be designed and properly operated. To obtain this result the services of both the engineer and chemist must be employed where neither is looking for special monetary considerations.

Whether the solution of the problem is sufficiently advanced to warrant a committee of sanitary engineers to prepare general specifications covering design, construction and guarantees is a matter for your committee to determine. My own opinion is that it has not and therefore that such an attempt would not have the influence on the art that your committee desires.

I suggest that the committee might well collect and publish in a comprehensive and readable form the existing reliable data on garbage disposal, sparing nobody, no type or process in such a publication, to the end, first, that the public may be informed of the state of the art, and secondly, that by thus educating the public a change of attitude may occur which will result in calling in the services of the engineer and chemist; then and then only can proper specifications and designs be formulated.

J. A. Jensen—I believe that such specifications would be helpful owing to the lack in many cases of efficient supervision, but such specification should generously recognize the various successful types of incinerators. I believe the design should be in accord with sound mechanical principles and that approved material should be used for construction. The tests should take into account the varying grades of refuse met with in different places—a matter that is usually lost sight of.

M. M. O'Shaughnessy—The condition of garbage disposal plants in our large cities is a disgrace and a reflection on the engineering profession, which should have the matter in charge. Immense sums of money have been invested in fake incinerators inclosing expensive machinery which is never used or fails to function. Witness the suspension of incinerators and garbage disposal plants in Seattle, Atlanta, San Francisco, Los Angeles, and New York. Think of the crime of dumping garbage from New York in the ocean and polluting all the beaches up and down the shore line! I believe by collaboration of engineering talent incinerator specifications could be drawn which would serve as a standard for the city engineers of our large cities.

Steuart Purcell—I believe it is both practicable and desirable that standard specifications be drafted for this purpose, as they would be a most valuable guide to municipal engineers, even though it might be necessary to modify them considerably to fit local conditions.

Standard specifications drafted by a committee like yours would undoubtedly

prevent the ill-advised expenditure of large sums of money—of which there are many instances—on the construction of plants which prove to be failures and are soon abandoned or operated with very unsatisfactory results, and at great economic loss.

HOW FAR SHOULD A CITY GO IN COMMERCIAL ENTERPRISES?

By H. C. Bottoroff, City Manager, Sacramento, Calif.

This subject is no doubt being debated today at greater length than heretofore because it has to do with the question of municipal ownership.

Water Works

Municipal ownership and operation of public utilities has made considerable progress in the United States during the past few years. Municipal ownership of water supply has made the greatest development everywhere. Among 75 American cities having populations of 100,000 and upward, all but a half dozen have municipalized their water supply service. This is largely because water supply and lighting and transportation is intimately related to the public health of the congested centers.

Electric Light and Power

Electric lighting ranks next in the support of municipal ownership. There are approximately 6,000 electric lighting plants in American municipalities large and small, of which more than one-fourth are in public development.

In California there are numerous instances where the control of the utility service such as water, gas, electricity, garbage disposal, wharves, recreation, etc., have proven that the cities are justified in conducting same, as the low cost of operation has been of great benefit to the citizens.

The City of Redding in northern California, the latter part of 1921, acquired the distributing system from a power company for $57,356. The legal and other expenses brought the total up to $60,000, which represented the city's total investment. A statement submitted recently by the City Manager of Redding shows that the system has returned a profit of $79,497 from the date of purchase up to June 30, 1924. This money was apportioned to their general fund and a portion of the amount used for the redemption of bonds, and the balance went into street improvements. This was accomplished at a rate to the consumer lower than the rate previously charged by the private utility.

The City of Alameda, Cal., is another good example of what can be accomplished under municipal ownership. That municipality buys its power at wholesale and re-sells to the consumer at retail. Alameda has a system valued at $513,000, through which they effect a saving to the consumers and taxpayers of $148,000 annually, or an equivalent of 29 percent per year on the investment. Alameda has free street lighting and free lighting of public buildings without cost to the taxpayers. The prevailing rate at this time is considerably lower than that charged in the neighboring cities of Oakland and Berkeley.

The City of Los Angeles is one of the large cities to embark upon municipal ownership of generating and distributing of electricity. The rates prevailing in that city are 40.5 per cent lower than the rates charged by the Southern California Power Company outside of the city limits of Los Angeles, and 32 per cent lower than the rates charged by the power companies in San Francisco.

The City of Sacramento at this time has under way plans for the construction of a generating plant in the Sierra Nevada mountains, transmission lines to the city, and the acquiring of existing distributing systems within the limits of the district. Estimates prepared by the engineers, we are sure, will prove beyond a doubt that the city can accomplish as much as the cities already referred to, and will be able to deliver power for much less than the prevailing rate.

This, to my mind, is without a doubt a proper enterprise for a municipality to enter into.

Garbage

In the matter of collecting garbage: This is a service that has been given a great deal of thought by the city managers throughout the United States during the past few years and the records now show that the majority of cities are handling garbage on a self-supporting basis. Let me cite to you the experience of Sacramento along this line.

When the manager form of government went into effect, there were two private companies operating in the city and it was not an uncommon thing to receive from 60 to 75 complaints per day from householders regarding the service. Conditions went from bad to worse and it was finally determined by the

City Council to take over the handling of garbage. An ordinance was adopted and the city manager was authorized to employ men, obtain equipment, and take over the entire service. This was accomplished in a short space of time and immediately there was an improvement in service. At the present time it is a rare thing to receive more than nine complaints per day relative to service rendered by this department. The garbage department has been on a self-supporting basis from the very beginning. and has paid for all its equipment and cost of operation. There has been no increase in rates; in fact there has been an increase in service rendered and in a great many instances, particularly in the business section, a reduction has been made in the rates that prevailed prior to municipal operation.

Can there be any argument advanced against a municipality embarking upon an enterprise of this kind where it has a direct bearing upon the health of the community?

Wharves

Another utility that is being given more attention each year by the managers is the operation of wharves. Just recently in Sacramento a bond issue was put over which provided funds for the building of new wharves that increased the floor space approximately 100 per cent. The city administration secured from the federal government a change in the pier head line of the old wharves that added a value conservatively estimated at $500,000 to the value of the city's property. The interest and redemption on the bonds, as well as cost of operation, is taken care of from the revenue of the wharves which I am sure could not be accomplished under private ownership at the rates prevailing under municipal ownership. This is just one more example of a city being justified in entering into a commercial enterprise.

Recreation

For another example let us take the question of recreation as it exists today as compared with former years. Cities have long since provided parks and other open spaces for the use of the people, but it is only of late years that more positive measures have been taken in the way of facilitating public recreation. The older conception of municipal functions went no farther than the essentials of community life. It recognized the right and duty of the city to provide for public safety and convenience, but did not regard measures for public amusement as being within the sphere of governing powers. This provision, it was assumed, might better be left to voluntary organizations. But the old conception has been steadily broadening. Today the modern American city does not hestitate to plan its recreation program along very general lines. It is not an uncommon thing for cities to provide and maintain public baths, public gymnasiums, golf courses, recreation centers, summer camps, etc.

Summer Camp

Let me again refer to Sacramento's experience in operating a summer camp for the benefit of its citizens. The city secured a long lease from the federal government for a beautiful camp site in the high Sierras. The business houses in the city, in conjunction with the city administration, erected a summer camp that we believe is a credit to the city. Accomodations have been provided to take care of 200 people a day. The city provided for a generating plant to furnish electricity for the camp, a social hall and dining room with all modern equipment, showers, cabins, and many other facilities. The city charges for a two-weeks' vacation at the camp to any citizen of the municipality $17.50. This includes board and room. No stay is permitted longer than two weeks. The camp is self-supporting. At the time the city embarked upon this enterprise there was considerable complaint registered by resort owners in the section where the camp is located that it would interfere with their business and that the city had no right to enter into the resort business. This was rapidly proven to be incorrect. The intent of the camp was to provide a place where the man or woman earning a small wage, who could not afford to go to the more expensive places, could have a vacation.

Is not a city justified in doing this for its citizens, especially where the recreation provided is paid for by the citizen receiving the benefits, and there is no deficit to be made up by the taxpayers as a whole?

Golf Courses

The same applies to golf courses. I am informed that there are over 100 cities in the United States that maintain municipal golf courses and these courses, as a rule, are on a self-supporting basis. Sacramento maintains two golf courses that provide recreation for a large number of our people.

Auto Camps

One other activity coming under recreation that would be termed a commercial enterprise is the conduct of a municipal auto camp. The cities in California are confronted with the necessity of providing a camp where the tourists can stop over at a nominal cost. Every summer there are hundreds of thousands of automobile tourists visiting the California cities and it was necessary to provide facilities for these visitors. In Sacramento during the year 1923 the camp cared for more than 65,000 people. The camp is maintained on a self-supporting basis, is under proper sanitary regulation, and has brought thousands of dollars to the city as a result of its operation. The cry was raised by the hotel men when the camp was first established that it was detrimental to their business, but it was only a short time until they realized that this argument was erroneous. Service such as Sacramento and many other cities are rendering through municipal auto camps could not be given under private control at the price charged.

Legal Rights

The question has been raised at numerous times as to the city's legal right to enter into commercial activities. The trend of the latest decisions of courts of the last resort is to sustain the rights of cities to engage in commercial enterprises where these enterprises have to do with the welfare and protection of its people. Recently the Nebraska Supreme Court held that where a necessity has arisen, the city would have a right to conduct a fuel business. There have also been decisions by the Supreme Courts of Maine, Minnesota, Missouri and California in favor of the cities.

Beyond the ownership and operation of things which are natural monopolies, there is a serious doubt in my mind as to any city being justified in going into what is considered "Private Business." A city is dependent almost entirely on its business interests, both in furnishing employment for labor and furnishing tax rolls on which assessments can be based to carry on the expenses of government. Any business activity by a city as such which goes beyond the protection of its people is wrong in principle.

Municipal ownership means that the consumer will get the service at cost, whatever this cost is. It further means that the people will have something to say about the manner in which the utility service is conducted.

There is no greater service that the public official can render to the citizens than by getting behind the movement of municipal ownership of those activities which are essentially natural monopolies.

The foregoing paper by Mr. Bottoroff was presented at the recent annual meeting of the California League of Municipalities.

OBSTRUCTIONS TO VIEW AT GRADE CROSSINGS

By Earl Crawford, Member Indiana State Highway Commission, State House, Indianapolis, Ind.

(Editor's Note: The following paper by Mr. Crawford was presented at Indiana's First Grade Crossing Saftety Conference, held in Indianapolis, Oct. 14 and 15, 1924. The paper was accorded general approval.)

In dealing with this subject I am going to confine myself to conditions as I have observed them at crossings outside cities and towns. I want to do this because I believe it is at these grade crossings in the country where most of the accidents occur and where the most lives are lost, and yet that is where the least money is spent. This is another way of saying that the money we have been spending for grade separations has not been altogether from the standpoint of saving life. If this fact could be driven home it would bring about a better distribution of the money budgeted by the railroads and appropriated by county and city officials for grade separation purposes.

Topographical Obstructions

First, I want to speak of obstructions which are due to the topography of the country through which the railroad and highways pass. Grade limitations of the railroads are much lower than that of the highways and, therefore, grade crossings have been made to conform to railroad grade. In order to do this many crossings occur in deep cuts or on high fills and frequently where there is a sharp curvature of the railroad or highway, or both.

To this condition add the fact that quite often we find timber or growing crops on one or both sides of the crossing and we have a word picture of numerous situations all fraught with great danger to the traveling public. There is a compensating influence in connec-

tion with such crossings in that they are the ones that lend themselves to an easy and economical grade separation.

It is crossings of this kind which, in my judgment, should be eliminated as rapidly as funds are available. Some of these crossings can be eliminated by relocating the highway. This method, of course, should only be used where distance and alignment of the highway are not sacrificed; others can be eliminated by an overhead or an underpass. The cost, of course, should be a factor in determining the method used and, whatever the cost may be and wherever it may be spent, it should be on a fifty-fifty basis.

A classification of these crossings should be worked out by the preparation of lists, the sequence of which should be determined by the traffic served and the hazards involved. This classification should be considered by the political subdivisions and the utilities interested, and a joint budget or budgets should be agreed upon and the money available for grade separations spent in accordance with such classifications. By such an arrangement the greatest saving of life would be obtained for the money expended.

There are many crossings in open country where the view is badly obstructed by timber, orchards, cornfields and quite often buildings. In many instances of this kind a small amount of money spent for removing the obstructions or relocating the buildings would greatly improve the vision and lessen the danger until such time as separation of grade could be made.

There is another class of obstruction to the view which in the past has been altogether too numerous and that is advertising signs placed in a strategic position from the advertisers' standpoint. Instead of being a source of information to the traveler, these wide-spreading billboards, marring the landscape and obstructing the view, become a death trap for the user of the roads.

In 1921 the State Highway Commission ordered the removal of all advertising signs from roads of the State system. This was done in order to make the road markings more effective and to relieve dangerous curves and corners from signs that would obscure the vision of the user of State highways. Many counties have adopted such a policy and advertising signs are rapidly disappearing from the rights of way of public highways. There is no good reason why a single sign that obstructs the view should be allowed to remain.

Automatic Signal Devices

Crossings where the railroad and highway meet at other than right angles make it difficult for drivers of motor vehicles to see in both directions. In many situations of this kind a grade separation would be impracticable. In such cases an up-to-date automatic signal device connected with the railroad block system should be installed and the drivers on the highway be placed under the same criminal responsibility as a railroad engineer who would willfully disregard such a signal at the crossing of another railroad.

Standing Freight Cars

Another class of obstruction all too common is caused by the practice of the railroads in leaving long cuts of cars standing on side tracks at places where the view of the main track is almost completely cut off. It seems to me that this is indefensible, especially when it occurs out in the country, because many times it happens through thoughtlessness of train crews who could just as well shove the cars further down, thus giving better vision.

We have had some co-operation on the part of the railroad officials in preventing this condition along State highways, but there is still room for further improvement. There are some instances of this kind where it might be necessary to relocate the switches or sidings, which would cost less than a grade separation and be far more practical. This class of obstruction can and should be disposed of.

If all the grade crossing accidents occurred at crossings where the view is obstructed, the problem would be considerably lessened, and, as I have pointed out, these could eventually be taken care of through separation, relocation and automatic signal devices or flagmen, but my information is that the greater number of accidents occur at crossings where there is ample opportunity to see approaching trains.

The Irresponsible Automobile Driver

There are two reasons for this: one is that there are too many people driving motor vehicles who have barely learned to walk; who has eyes but will not see, and who have ears but will not hear; and so long as there is no strict provision made for ruling the careless, incompetent driver off the highways, there will be accidents and a small per-

centage of them will be at grade crossings.

Second, there are too many law-defying, drunken drivers using the highways; and to consider ways and means of eliminating the dangerous grade crossings and allow this menace to life and property to go unheeded will indeed be "penny wise and pound foolish." It seems to me it would be easier and cheaper and more in line with common sense to get rid of this class of drivers.

As I understand it, this conference was called primarily to consider ways and means of saving life, and I want to go on record as believing that "booze" mixed with gasoline is a greater menace to life and property than all the grade crossings combined, and it is up to every sober, law-abiding driver of a motor vehicle for the protection of himself and family to insist on the same degree of sobriety in automobile drivers as railroad officials demand and get from their employes. When this comes about, and it will, loss of life on the highways will be reduced at least 50 per cent.

In conclusion, I want to digress just a little and touch on obstructions to the view where grades have been separated. Much of this work which has been done in the past was done with a view of taking the small amount of horse-drawn traffic safely over or under the railroad, but with increased traffic, motor driven, these holes in the ground and narrow mountain paths with their restricted vision have become as much a source of danger as the grade crossings.

Much that has been done in the past needs correction. This emphasizes the importance of a sane, sensible, business-like expenditure of the money available for only the small part of the work that should be done. A careful consideration of past mistakes as well as present conditions will help much in formulating a program to meet future requirements.

The statements herein set forth are the views and policies of the Indiana State Highway Commission whom I represent in the presentation of this paper.

HIGHWAY RESEARCH WORK IN OHIO

Ohio is likely to be the model for the country in certain types of roadway construction, following an extensive study of subgrade materials and their resultant effect upon the wearing courses of pavements. The undertaking of this study and experimentation was announced recently by G. F. Schlesinger, State Highway Engineer.

The study of this subject will cover a period of over a year, and it is being followed with intense interest by the leading federal and state highway engineers, who assert it to be one of the most important research efforts of its kind ever undertaken in this country.

Cooperating with Mr. Schlesinger will be Professor F. H. Eno, of the faculty of civil engineering of the Ohio State University. Professor Eno has devoted much of his professional career to the study of roads and has been detailed by the university and the state division of highways to take charge of the experimental work being done in this direction.

The study will consist of ascertaining by practical test the atcion that different types of clays, loams, and other subsoil materials have upon the road's surface, and the experiments will also include the construction of experimental layers between the sub-grade and pavement, these layers varying from 2 to 6 ins. in thickness and being composed of crushed stone, gravel, slag, sand, cement mixed with clay, and other materials.

Seven miles of such experimental roadway will be built in Washington County on the Athens-Marietta Road. These seven miles will contain several different sections, each constructed of different subgrade materials, and observation of the effect of these materials upon the roadway's surface will be made and carefully checked, to determine the value of these so-called "insulating layers" under ordinary conditions of highway traffic.

It is believed that porous materials, such as crushed stone, slag, gravel, etc., when interposed between the sub-grade and the pavement, will have the effect of arresting capillary attraction. This is the attraction which some clays have for water, resulting in drawing moisture from a considerable distance, and thus affecting adversely the durability of the roadway. This absorption of water is similar to that shown by a blotter dipped in ink, and while this is a somewhat exaggerated case, the theory is similar. When the sub-foundation of a roadway is composed of dense impervious materials, the substructure is likely to become affected by the moisture attracted to it by capillary action. The theory upon which the newer type of sub-grade construction is being tested is that it will

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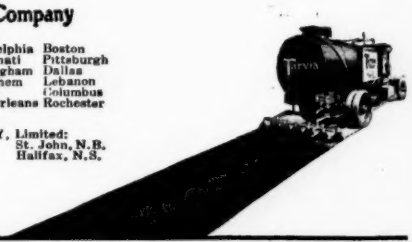

afford a greater flexibility to the roadway with a more even capillary attraction, and thus avoid water damage common to roadways of rigid sub-structure type.

However, not only will flexible types of roads, such as macadam, be tested, but the rigid roadway type will also be carefully studied in its relation to subgrade conditions, and the effect of "insulating layers" upon the durability of the top course.

In addition to this program of experimentation, there will be numerous other soil tests made all over the state, with relation to their moisture content and porosity. Other tests will also be made in an effort to ascertain the effect of soil and atmospheric conditions upon the maintenance and repair of roads.

Cooperating in these experiments will be the United States Government and the Ohio State University experiment station, and because of the eminence of the men engaged in the work and its character, the result of this study, it is believed will be highly important to those interested in scientific and economical highway construction, not only in Ohio, but throughout the nation.

This means that the experiments and research work now being inaugurated will be of intense interest not merely to engineers and highway officials, but to taxpayers as well, as the practical nature of these experiments will undoubtedly, according to the belief of Mr. Schlesinger and of L. A. Boulay, director of highways of Ohio, have a large influence in determining the most valuable and economical future types of roadway construction to be employed under all possible soil and atmospheric conditions.

This will make for better roads and less waste of money in determining the proper type of roadways under any and all conditions.

SEPTEMBER MUNICIPAL LOANS SMALLER

State and municipal bond flotations reached their peak for the current year in June, when loans aggregated $286,487,401. July and August were also big months with the output of new issues running well over $100,000,000. September, however, shows a sharp decline, the total of new loans being $82,133,456, according to the Daily Bond Buyer of New York. This is the smallest total for any month since September of last year.

The following table, compiled by the Daily Bond Buyer of New York, compares the output of long term state and municipal loans in September and the nine months ended September 30 for ten years:

	September	Nine mos. end. Sept. 30
1924	$82,133,456	$1,112,678,109
1923	57,506,117	803,481,043
1922	119,208,708	1,057,331,108
1921	100,797,646	823,009,032
1920	70,712,506	565,902,596
1919	72,787,676	517,491,709
1918	19,790,397	207,032,540
1917	34,283,642	366,764,292
1916	19,399,642	376,341,515
1915	28,768,418	395,364,676

THE SMALL UNIT IN RAIL SERVICE

(*Kansas City, Mo., Times, Feb.* 6, 1924.)

The significance of the fact that two of the leading railway systems of the United States are turning to motor trucks as auxiliaries in short freight hauls will not be overlooked by traffic officers alert to modern needs and conditions. The lines are the Pennsylvania and the New York Central. The former system has been using trucks for some time, and recently the New York Central has inaugurated that service on a short line in New York State.

That is one way to deal with the motor vehicle competition, of which many railroads today are complaining. Whether it is the most effective way yet is to be established. Certainly, an increasing volume of freight is to be handled on the highways, whatever the management of the service. But, aside from the problem of road maintenance, which this use of highways provokes, there is yet another way out for the railroads. That lies in extended use of the small transportation unit, such as the gasoline car, on the railroad tracks themselves. That unit already has proved its value, especially in foreign countries.

Why should not the gasoline unit prove the salvation of the short line railroad in the handling of both freight and passengers? Has it been given a fair test in this field? Wouldn't it be practicable to use this unit where the use of a train of several coaches is found too expensive, yet where small towns and rural districts were in need of rail service? Would it be necessary to curtail or abandon service in so many cases if this plan were used?

Contracts Awarded

ROADS AND STREETS

Ala., Anniston—Morgan-Hill Paving Co., Woodward Bldg., Birmingham, Ala., awarded contract for street paving. Est. cost, $110,000.

Ala., Birmingham—City let contracts to improve 26 streets, totaling $225,000: C. F. Browne, 224 Cornelia Av.; Dunn Constr. Co.; Henning & Bragan; Southern Rds. Co.; Morgan-Hall Paving Co.; H. N. Bowdry, Farley Bldg.; A. H. Dimijian, Woodward Bldg.; Bessemer Engrg. & Constr. Co., 122 19th St., Bessemer—all other companies at Birmingham.

Ala., Huntsville—Lasley Bros., Chattanooga, Tenn., awarded contr. to pave 2 miles Whitesbury Pike so. of Huntsville, 5-in. conc. base and 2-in. asphalt surface, at $59,835.

Ariz., Ajo—Miller & White, Yuma, awarded contract at about $60,000 by Pima Co. Bd. of Supvrs. for paving 6 blocks of Ajo's main street.

Cal., Hawthorne—Geo. R. Curtis Paving Co., Inc., 336 E. 58th St., awarded contract for impvt. of Dera, Euclid, Menlo and other thoroughfares, at $289,083. Work involves grading, curbs, walks, etc., and 638,872 sq. ft. 1½-in. Willite pave. on 2½-in. conc. base.

Cal., Los Angeles—Southwest Paving Co., 801 Washington Bldg., awarded contract by Board of Supvrs. at $37,964 for impvt. of Center St., Atlantic to Glenarm Aves.; and Atlantic Ave., Santa Barbara to Walnut Sts.; Co. Imp. No. 106; R. K. Smith, 1124 S. St., Andrews Pl., contract by Bd. Pub. Wks., for impvt. of Hollyridge Dr., 1,483 ft. no. of Rutherford Dr. and Graciosa St., at $17,478; Cristich, Mandic & Cristich, Douglas Bldg., contract at $131,303 to improve Ave. 56, Raber to Hub Sts.; Geo. H. Oswald, 366 E. 58th St., awarded contract by Bd. Pub. Wks., at $30,478 for impvt. of 63rd St., Normandie to Western Aves.

Cal., Santa Ana—Griffith Co., 502 L. A. Ry. Bldg., Los Angeles, awarded contract by Orange Co. Bd. of Supvrs. at $74,000 for paving 5 miles on Arrow Hwy. (W. 17th St.)

Cal., Santa Monica—Kneen Paving Co., Dudley Bldg., Santa Monica, awarded contract at $79,707 for impvt. of Cambridge St.—Darlington Ave. to Wilshire Blvd.—involving curb, walks, sewers, cast iron water mains, oil and rock paving, cement conc. paving.

Fla., Sarasota—Finley Method Co., Jacksonville, awarded contract by Sarasota Co. Comrs., at $276,413 to build 6 roads totaling 33 miles.

Fla., Tallahassee—W. P. McDonald Constr. Co., Lakeland, contract by State Rd. Dept., for 10 miles State Rd., No. 2—Lowell to Ocala—lime rock base, sheet asphalt surf., at $324,075.

Ga., Decatur—McDougald Constr. Co., Healy Bldg., Atlanta, and Sam E. Finley Contracting Co., North Ave., Atlanta, at $65,000, to pave 5 streets here.

Ga., East Point—State Hwy. Dept., East Point, let contracts for 9 road projects: Carroll Co., 8.007 mi. graded, Carrollton-Neunan, Dunn & Woodall, Atlanta, at $31,096; Crawford Co., 4.911 mi., sand clay or local gravel, Knoxville-Columbus, Dunn & Woodall, at $79,508; Monroe Co., 3.50 mi. conc. pavement—Forsyth to Macon, Whitlet Constr. Co., La Grange, at $87,286; Houston Co., 6.976 miles, gravel, Macon-Perry, Wallace Constr. Co., Norman Park, at $100,020; Atkinson Co., 8.796 miles, sand, clay, Pearson-Willacoochee, Caye-Andrews Co., Americus, at $38,159; Schley Co., 6.37 miles, graded and 2 miles pentration macadam on crushed stone base, Ellsville—Americus, Campbell Contracting Co., Columbus, at $63,753; Lamar Co., 5.7335 mi., topsoil, Barnesville-Macon, Wynn & Potts, Newnan, at $42,992; Putnam Co., 5.461 mi., topsoil, Eatonton-Gray-Macon, to J. and J. B. Miller, Baconton.

Ill., Mattoon—Thornton & Son, Mattoon, awarded contract for grading, curbing, guttering and hard surfacing Charleston and Illinois Sts., etc., Engineer's est., $140,000.

Ill., River Forest—Standard Paving Co., 341 N. Parkside Ave., Chicago, awarded contract for impvt. of Lake St.—14,500 sq. yds. brick to be removed and 20,500 sq. yds. asphalt on 7-in. conc. to be laid; 14,500 feet integral curb, etc., at $111,983.

Kans., Anthony—Shultz & Shultz, Anthony, awarded contract for grading and sand clay surfacing 5.524 mi. F. A. P. 209-A and 12.847 mi. F. A. P. 206-A, 18 ft., Harper Co., at $34,738 and $91,175, respectively.

Ky., Henderson—Premier Constr. Co., 906 Lemcke Bldg., Indianapolis, Ind., awarded contract for asphalt sheet paving, at $123,145.

Ky., Hickman—Bridges Constr. Co., Wabash Indiana, awarded contract for paving 5 miles, various streets at $127,000.

La., Baton Rouge—La. Hwy. Comn., Reymond Bldg., Baton Rouge, let contracts for 7 roads as follows: Red River Parish, 4 sections; 10 mi. Shreveport-Natchitoches Hwy., McKeith Constr. Co., Glenmora, $80,949; 9.1 mi. Shreveport-Natchitoches Hwy., Hogsett & Co., Shreveport, at $78,704; 10.16 mi. Shreveport-Natchitoches Hwy., to Hogsett & Co., at $74,797; 1.37 mi. Armistead-Coushatta Hwy., to Hogsett & Co., at $10,639; Evangeline Parish, 2 sects., 5.87 mi. Ville Platte-Bunkie Hwy., to J. C. Wimberly, Church Point, at $50,222; .86 mi. Eunice-Bunkie Hwy., Barbour & Epple, Eunice, at $7,455; Vermillion Parish, 10.8 mi. Abbeville-Lafayette Hwy., Laiche & Miller, Morganza, at $63,700.

La., Baton Rouge—Thibodeaux & Harrison, Main St., Baton Rouge, awarded contract to gravel 12 streets, at about $94,600.

Maine, Augusta—State Highway Commission let contracts as follows: grading and bitum. macadam surfacing on 2.45 mi. in Frankfort, to McCabe & Co., 24 East Concord St., Boston, Mass., at $97,679; grading and gravel surfacing 5.72 mi. in Winn to Douglas & Litchfield, Brunswick, at $70,347; J. H. Fannon, 28 Hinkley St., Somerville, awarded contract by Metropolitan Dist. Comn., 1 Ashburton Pl., Boston, for surfacing and grading West Border Rd. and Pleasure Dr., in West Roxbury, at $31,313; Rowe Contg. Co., Malden, let contract for

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Municipal and County Engineering

702 Wulsin Building INDIANAPOLIS, IND.

constructing various streets in Medford (Boston Postoffice, at Engineers est., $25,000.

Mass., Boston—Dept. Pub. Wks., Div. of Hwys., State House, Boston, let contract for bitum. macadam pavement and bridge on 2,943 ft. hwy. in Russell, to Adams & Ruxton, 387 Main St., Springfield, at $44,983; bitum. macad. pave. 3,065 ft. hwy. in Groveland, to Greenough Constr. Co., So. Acton, at $13,827; rein. conc. pave. and bridge on 1,500 ft. hwy. in Lee, to Lane Constr. Co., 37 Colony St., Meriden Ct., at $39,528; steel bridge and approaches on 900 ft. hwy. in Sheffield, to L. D. White, Inc., 1 West St., Kingston, at $52,888; Central Constr. Co., 228 Southampton St., awarded contract for repairing bitum. pave. on various streets, at $82,700.

Mass., Boston—M. DeMatteo, 12 Rowe Pl., Roslindale, awarded contract by Park Dept., 33 Beacon St., for widening and bitulithic resurfacing of road in Franklin Park, Sec. 1, Bluehill Ave., to Valley Gate Triangle, at $51,667; Metropolitan Dist. Comn., 1 Ashburton Pl., Boston, let contract for surfacing with Simasco bitum., 30,000 sq. yds. Revere Beach Reservation Dr.—Eliot Circle to Revere St., in Revere; 1,000 tons crush. stone, to Simpson Bros., 77 Summer St., Boston, at $63,125.

Miss., Belzoni—S. A. Gano, Maison Blanche Bldg., New Orleans, La., awarded contract by State Hwy. Dept., Jackson, for 4 mi. conc. pavement through Belzoni in Humphreys Co., at $113,000.

Miss., New Albany—Nixon & Phillips, Water Valley, Miss., awarded contract at $155,000 for 20 mi. graveling of road in Union Co.; contract let by State Hwy. Dept., Jackson, Miss.

Miss., Winona—Young-Hall Constr. Co., Nakomis, Ill., contract by State Hwy. Comn., Jackson Miss., at $92,436, for 12 mi. graveled road from point north of Winona to Grenada Co. line.

Mich., Lansing—State Hwy. Comr. Rogers submitted at meeting of State Administrative Board Committee following bids on which committee passed favorably: L. W. Edison, Rogers, Mich., F. A. P. 129-A1, 4.962 mi. 18-ft. conc., at $23,159 per mi.; Sec. 2, 5.088 mi. 18-ft. conc., at $26,396 per mi., and Sec. 3, Bear Lake Village, .868 mi. 20-ft. conc., at $33,366.79 per mi.; Louis I. Goldberg, Sec. 4, 6.835 mi. 18-ft. conc. no. of Bear Lake Village, at $27,841 per mi.

Mich., Lansing—J. Bright, Pigeon, awarded contract by State Hwy. Dept., Lansing, for grading and surfacing 5.808 mi. State Trunk Line Rd., 28-20, Huron Co., at $109,819.

Mich., Lansing—State Trunk Line contracts let as follows, week ending Sept. 6: Rd. 14-56, Clinton Co., Greenbush Twp., C1 T-beam brdg. to Baxter & Kohlmeyer, Ithaca, Mich., at $4,051; 11-58, B, Oceana Co., Weare & Hart Twps., C1 7-in. F-Std. 18-ft. wide, 2.12 mi., to Hersey Gravel Co., Hersey, Mich., at $51,129 (Rd. 11-58, B est. cost cement, $17,273); 35-3, Delta Co., Maple Ridge Twp., C1 pen. mac. 16 ft. wide, 5.721 mi., to Delta Co. Rd. Comn., Escanaba, Mich., at $93,660; 27-20, Huron Co., Pt. Austin Twp., C1 E-bit. on 7-in. sandstone base, 16 and 20 ft. wide, 5.808 mi., to Jas. Bright, Pigeon, Mich., at $109,819; Rd. 14-12, Hillsdale and Lenawee Cos., Pittsfield and Hudson Twps., C1 G and DS, 3.135 mi., to Harry B. Lewis, Adrian, Mich., at $23,931; 14-18, A2, Lenawee Co., Rollin Twp., C1 G and DS, .383 mi., to W. W. Shanor, Albion, Mich., at $1,434; 14-18, B, Hillsdale Co., Wheatland Twp., C1 G and DS, 5.255 mi., to W. W. Shanor, Albion, Mich., at $22,502; Rd. 14-55, B, Lenawee Co., Woodstock Twp., C1 G and DS, 4.167 mi., to Art. Johnston, Morenci, Mich., at $22,622.

Mo., Jefferson City—State Hwy. Dept., Jefferson City, let contract for 3 roads as follows: Grundy Co., 4.868 mi., 30-ft. graded earth—Trenton so., C. P. O'Reilly & Co., St. Louis, at $30,440; Nodaway Co., 2 sects., to C. H. Atkinson Pav. Co., Watertown, S. Dak., 2.212 mi., earthwork from Maryville east and west, at $20,683; 2.212 mi., 18-ft. conc. surfacing—Maryville east and west at $33,747.

Mont., Helena—State Hwy. Comn. awarded federal aid contracts aggregating $170,000 for projects in Missoula Park, Gallatin and Glacier Cos.: Lalonde, Polk & Powers, Bainville, contract for grading and surfacing 10.68 mi. on Babb-Cardson Hwy., Glacier Co., at $64,918; McGuire & Blakeslee, Great Falls, contract to build steel and concrete bridge over Kennedy Crk., on same highway, at $18,977; A. Moogey, Bozeman, contract to construct steel and concrete span over Biter Root River on Yellowstone Trail, Missoula Co., at $4,981; Buck Helean Hudson, contract for more than a mile of approach road to bridge, at $16,128; H. Downer, Clyde Park, contr. to grade and surf. 2.99 mi. on Bozeman Hill sec. of Yellowstone Trail in Park and Gallatin Cos., at $32,718.

N. J., Freeholder—Jannarone Constr. Co., 225 Passaic Ave., Belleville, awarded contract for conc. paving on 1.63 mi. W. Long Branch-Interlaken Rd., at $70,418.

N. J., Sparta—G. Van Keuren, Sussex, awarded contract for concrete pavement, 10-ft. strip on 3.67 mi. rd., from here to Morris Co. line, at $78,038.

Ohio, St. Clairsville—C. Bell & Sons, New Athens, awarded contract by Belmont Co. for grading and conc. pavement on Flushing-Holloway Rd., at $46,070; tar-bound macadam pavement, Neffs-Willow Grove Rd., to Dougherty Constr. Co., Steubenville, at $59,953.

Ohio, Steubenville—Federal Asphalt Paving Co., Main and D Sts., Hamilton, awarded contract for Natural Lake asphalt paving on Market—Liberty Ave. to Brady La., at 61,000.

Ohio, Steubenville—Meriner Contg. Co., Athens, awarded contract for concrete paving on 1,702 mi. ICH 7 Rd. bet. Georges Run and Brilliant, 20-ft., at $125,300.

Ohio, Zanesville—Highway Constr. Co., 903 Lorain County Bank Bldg., Elyria, awarded contract by Board of Control, for sheet asphalt paving in W. Main St., at $105,174.

Okla., Enid—Hyde Constr. Co., Enid, awarded contract for 4½ mi. hard surf. road—Enid no. to Grant Co. line, at $140,000; Yates Constr. Co., Ada, Okla., contract for 4½ mi. from Enid to Grant Co. line, at $125,000.

Okla., Norman—Gibson & Mitchell, Paul's Valley, awarded contract by State Highway Comn., for 16 mi. conc. and rock asphalt road—Lexington to Norman, at $499,012.

Okla., Stroud—H. L. Cannaday Co., 1104 S. Lewis St., Tulsa, Okla., awarded contract to pave, etc., in Paving Dist. No. 1, 3-in. vertical fibre brick, asph. filler, sand cushion, at $74,230.

Pa., Harrisburg—Dept. Highways, Harrisburg, let following contracts: Grade and rein. conc. surf. on 30,963 sq. yds., Rts. 181, Application 2130, Alleghany Co., to Monsteller & Virgin, Wilkinsburg, at $178,794; 18,450 sq. yds., Application No. 2,735, Jefferson Co., to Milliron Constr. Co., Du Bois, at $102,905; 48,779 sq. yds., Application 2839 and 2861, Someret Co., to Corrado and Galiardi Constr. Co., Connellsville, at $244,732; 10,740 sq. yds., Application 2616, Somerset Co., to Vipond, Strite & Moore, Hollidaysburg, at $52,294; 26,114 sq. yds., Rte. 183. Application 2118, Columbia Co., to J. Christiano, Shamokin, $125,642; 38,605 sq. yds., Rte. 304, Application 3140, Erie Co., to C. H. Constr. Co., Erie, at $196,789; 70,551 sq. yds., Rte. 63 and Spur, Indiana Co., to R. H. Cunningham & Son, Turtle Creek, $324,756; grading, etc., 20,655 ft., Rte. 944, 16 ft. Elk Co., to L. F. Edwards, Greensburg, at $37,219.

R. I., Providence—State Board of Public Roads Providence, awarded contract for conc. paving on 6.18 mi. Nooseneck Rd., in Exeter and Wyoming, to C. W. Blakeslee & Sons, 58 Waverly St., New Haven, Ct., at $273,665.

S. C., Columbia—State Hwy. Dept., Columbia, let contracts to surface 2 sects. of roads: 10.87 mi. Augusta-Allendale rd., W. R. Carson, York, at $95,000; 20-mi., Barnwell-Ellenton Rd., Newell Constr. Co., $120,000; to Funderburk Constr. Co., 2 brdgs.

S. D., Pierre—State Hwy. Comn., awarded contracts as follows: F. A. P. 153, Union Co., pave .37 mi., one course Portland cement conc., 4.680 sq. yds., $2.55 per yd., to Booth & Olson, 120 Virginia, Sioux City, Ia., at $13,083; F. A. P. 187B. Chas. Mix Co., grading 7.42 mi., to R. P. England, Murdo, at $63,586.

Tex., Center—Hannah Constr. Co., Colgin Bldg., Waco, awarded contract by Shelby Co., to grade and gravel 11½ mi. State Hwy., No. 35, at $146,000.

Tex., Crosby—Smith Bros., American Exchange Bldg., Dallas, awarded contract by Houston Co., for

6.9 mi. 16-ft. conc. on State Hwy. No. 21, at $202,-331.

Tex., Houston—Valient & Toomey, Farmers & Merchants Bldg., on Washington Ave., at $131,439; Smith Bros., Inc., 2402 W. Dallas St., Houston, contr. at $33,709 for asphaltic conc. pavement on Washington Ave., from tracks to Yale St.

Tex., El Paso—Veater & Davis, awarded contract by El Paso Co. to build 7 mi. waterbound macadam on San Elizario-Fabens Rd., at $62,126.

Tex., Jacksonville—Smith Bros., American Exchange Bank Bldg., Dallas, awarded contract to pave various streets with Uvalde rock asphalt, at $154,000.

Tex., Jasper—R. H. Minton, Hemphill, awarded contract to grade, construct draing. structs. and gravel surf., 9.10 mi. State Hwy. No. 8, Jasper Co., at $139,845.

Tex., La Grange—Tibbetts Constr. Co., Mineral Wells, awarded contract for 9.40 mi. Carmine- Ledbetter Rd., at $102,001.

Tex., Temple—K. S. Hull, Jr., Temple, awarded contract by City Comrs. to pave about 50 blocks in residence section with vit. brick and concrete, at $212,000.

Tex., University Park—City let contracts for paving at cost of $180,000 as follows: Central Bitulithic Co., Praetorian Bldg., for Hillcrest Ave. and University Blvd., and Uvalde Paving Co., both Dallas—7 streets and drives.

W. Va., Charleston—Kanawha Co. let contracts for 3 roads: 1½ mi. Ferry Branch Rd.—Ferry Branch to So. Charleston Bdrg., to Greybill & Bruce, Boyd Bldg., Charleston, at $33,702; 1 mi. Charleston-Hamlin Rd., Greybill & Bruce, at $28,-881; 1-5 mi. cement Teays Cemetery Rd., below St. Albans, to Isaac Peters, at $5,782.

SEWERAGE AND SEWAGE TREATMENT

Ala., Birmingham—Wood, Rucker Constr. Co., American Trust Bldg., awarded contract for constr. of 10 blocks of storm sewers in Spring St., and for 5 blocks in 40th and 42nd Sts., at $143,144.

Cal., Los Angeles—N. Chutck & L. Vuksich, 343 Wilcox Bldg., awarded contract by Bd. of Pub. Wks., for sewers in 6th Ave.—Vernon Ave to 50th St.—at $39,150; C. E. Green, Western Mutual Life Ins. Bldg., contract for storm drain in Mesa St., at $63,297.

Cal., Los Angeles—Thos. Haverty Co., 8th and Maple, contract by Bd. Pub. Wks. to construct Sec. 15 and Sec. 16, no. outfall sewer, at $158,765—City to furnish materials; C. H. Johnston, 752½ N. Edgewood Pl., contract for constr. of Boyle Hts. storm drain No. 2, at $172,000; Leo Milletich, 610 W. 5th St., contract by Bd. Pub. Wks., at $8,700, for sewer constr. in Country Club Dr.—Longwood to Sycamore Aves.

Cal., Culver City—R. A. Garnett, Loew State Bldg., Los Angeles, awarded contract for vit. sewers in Impvt. Dist. No. 2 to connect with Los Angeles City outfall, at $38,729.

Cal., Santa Barbara—J. H. Tillman Co., Ry. Exchange Bldg., Portland, Ore., awarded contract for 3,800 lin. ft. 42-in. outfall sewer, at $228,424.

Colo., Denver—D. Gibbons, 1358 Hannock St., awarded contr. for 8-24 in. vit. sewers, etc., in Globeville Special San. Sewer Dist., at $163,117.

Ont., Kitchener—Webster Constr. Co., 134 Carling St., London, awarded contract for extending sewers in various streets, at $39,400.

Ill., Niles Center—E. Harding, Racine, Wis., awarded contract for impvt. of various streets, at $521,000.

Ill., Rochelle—Hansen & Healy, Chicago, awarded contract by City Council, Rochelle, for sewage disp. plant, equipment, etc., at $32,312.

Iowa, Schleswig—W. B. Carter, Sieux City, awarded contract for sewer mains and disposal plant, at about $40,000.

West Roxbury (Boston, Mass., P. O.) W. Barrett & Co., 27 Hunneman St., Roxbury, contract by Dept. Pub. Wks., Sewer Div., for sewerage works in Stony Brook, Sec. 10, at $126,156.

N. J., Burlington—Grant & Driver, 56 McKinley Ave., Trenton, contract for extending sewers in various streets, at $43,818.

Ohio, Cleveland—Manson Co., Care Sewer Contractors Exch., The Arcade, contract for 1,270 ft. 3-ft. crock sewer and 2,720 ft. 12-18 in. vit. tile sewers in Pearl Rd., at $52,140.

Ohio, Cleveland—Salem & George Bros., Erie Bldg., awarded contract for 910 feet. 5-ft. rein. conc. sewer in Miles Ave., at $32,051.

Ohio, Cleveland—D. Pfahl, Berea Rd., awarded contract for 14,000 ft. 8-24 in. conc. sewer in Impvt. 58, Sewer Dist. 1, at $41,958; 11,260 ft. 12 to 24 in. vit. clay sewers to Kassauff & Co., 3182 W. 25th St., at $43,230.

Ohio, Idlewood—(Cleveland Hgts, P. O. A. Marra Constr. Co., Ulmer Bldg., awarded contract for sewers in 5 streets, at $50,288.

Okla., Cushing—Benson & Farrar, 122 S. 2nd. St., Guthrie, awarded contract for 7 mi. outfall sewers, 2 disp. plants, 2 Imhoff tanks, etc., at $106,000.

R. I., Providence—City let contract to F. W. Christy, 1074 Pontiac Ave., for sewer in Lorraine Ave., at $1,626; Slater Ave., $1,645; to F. A. Gammino, 92 Bway., for Cyr St., at $2,582; Calla St., $7,281; Intervale Rd. and Cole Ave., $3,575; Jastram St., $4,047; Bruno & Pettiti, 18 Tremont St., Boston, Mass., Thurbers Ave., $23,236; A. Aiello, 107 Westminster St., Roslyn Ave., at $5,325.

Tex., Corsicana—Contract for addn. to sewage disposal plant let to L. L. Winans, 1924 Heaton St., Ft Worth, at $65,581; 35 tons cast iron pipe and fittings to U. S. Cast Iron Pipe and Fndry. Co., Magnolia Bldg., Dallas, at $4,500; 15,000 ft. tile pipe fittings, etc., to San Antonia Sewer Pipe Co., Bedell Bldg., San Antonio, at $2,900.

Wash., Hoquiam—F. A. Keasel & Co., Hoquiam, awarded contract for concrete sewer in West End Dist., at $31,223.

Wash., Yakima—Oregon Constr. Co., Portland, Ore., awarded contract at $45,000 by Yakima City Comn., for Nob Hill sewer.

WATER SUPPLY AND PURIFICATION

Cal., San Francisco—Healy-Tibbitts Constr. Co., 64 Pine St., San Francisco, awarded contract for submarine pipe line in 408 lin. ft., Newark Slough and in 2,772 lin. ft. Dumbarton Strait, at $343,230.

Cal., Vallejo—Kaiser Paving Co., American Bank Bldg., Oakland, awarded contract by Vallejo City Council, at $248,109 for constr. of Gordon Valley water project dam.

Ont., Chippawa—Contracts on $120,000 water works and sewerage systems let as follows: Canadian International Filter Co., Ltd., 12-in. meter, Canadian General Elec. Co.; small meters, National Meter Co. of Canada, Ltd.; pumps, Golde & McCulloch Co., Ltd.—all of Toronto; 60,000 gal. steel elev. tank to Korton Steel Works, Bridgebury, Ont.

Ont., East York Twp.—McLaughlin Bros., 55 Gould St., Toronto, awarded contract for sewer and manholes in Donalds Ave., at $72,800.

Que., Three Rivers—Canada Iron Corp., St. Maurice St., awarded contract for furnishing 2,500 ft. 24-in., 3,600 ft. 20-in. and 1,700 ft. 18-in. cast iron pipe, at $63,000.

Colo., Denver—Hendrie & Boldhoff Mfg. Co., 1,039 17th St., awarded contract for 12 to 22 in. flange and hub valve at $1,738; 24-54 in. valves to O'Fallon Supply Co., 1625 15th St., at $57,866; 4-60 in. valves to Rensselaer Valve Co., Ontario St., Troy, N. Y., at $33,502.

Mo., Hannibal—Long Constr. Co., 600 Rialto Bldg., Kansas City, awarded contract for filter plant, basins, etc., in Riverview Park, at $209,000.

N. J., Keansburg—Layne & Bowler, 50 Church St., New York City, awarded contract by Boro. Council for improving water works, sinking 3 wells, etc., at $16,525; laying cast iron mains, pumping station filters, etc., to Spiniello Constr. Co., 187 Market St., Newark, at $170,399.

N. Y., Brooklyn—Paladino Contg. Co., 437 E. 120th St., New York, awarded contract by N. J. Hayes, Comr. Water Supply, Gas and Electricity, for water mains in various thoroughfares, at $8,-676; C. De Blasio, 339 7th Ave., Mt. Vernon, awarded contract for mains in Amundson, Adee, Arnow and Bissel Sts., etc., at $24,490; mains in Hinman St., Greene Ave., also Graham, Nelson, 11th, Hallett, Howland Aves., etc., 510 W 148th St., New York City, at $16,489, and $17,469, respectively; mains in Calamus, Water, Clinton, Fillmore Aves., etc., Long Island, to Stanley Constr. Co., Stein-

way Ave., at $24,574; mains in Astoria, 37th and 42nd Sts., to Kennedy & Smith, 93 Amity St., Flushing, at $12,200; Anable, Carolin and Packard Sts., Polke Roman, 13th, etc., to J. A. Gregory, 351 E. 124th St., New York, at $5,987, and $3,543, respectively. All contracts let by N. J. Hayes, Bldg., New York City.

N. Y., St. Johnsville—H. W. Golden & Sons, Troy, awarded contract for constr. of water distribution system, at $100,000.

N. C., Southern Pines—Tucker & Laxton, Realty Bldg., Charlotte, N. C., awarded contract for water and sewer impvts., here, at $175,000.

Ohio, Cleveland—Stange-Walsh Constr. Co., 2074 Fairmount Rd., awarded contract by Cleveland Water Dept., 1, 2 and 3-sty. and basement, 71x360 ft. brk. steel and conc. chemical house and mixing chambers for Baldwin-Fairmount proj., Contr. 54, Part 1, Engineer's est., $615,000.

Okla., Cushing—Benson & Farrar, 122 S. 2nd St., Guthrie, awarded contract for new impounding reservoir, earth dam, pipe lines, filter plant, 6,000 tons cast iron pipe, etc., at $343,000.

Okla., Stillwater—A. A. Davis & Co., Grain Exchange Bldg., Oklahoma City, Okla., awarded contract for installation of waterworks system, at $89,910.

Pa., Philadelphia—Dept. Pub. Wks. Bureau of Water, let Contr. 694 and 716 to M. & J. B. McHugh, 892 N. Markoe St., at $157,838 and $96,965 respect.; 714, to Acme Mach. Co., 316 N. 17th St., at $2,593; Contr. 715 to Specialty Eng. Co., Alleghany and Trenton Aves., at $1,098.

Tex., Beaumont—Thompson & Price, Kansas City, Mo., awarded contract for 4 m. g. filteration plant, at $132,000.

Tex., University Park—Miller & Kimbrough, awarded contract by city to dril ltwo Trinity sand artesian wells, at $45,000.

Va., Roanoke—City let following contracts for constr. of $700,000 exten. to water wks.' system, including 15 mi. 16-in. cast iron pipe, impounding dam, 6,000 ft. tunnel, 2,500,000 gals. capy. plant. Contr. No. 1, dam, to R. G. Ligon, 4100 Kate Ave., Baltimore, Md., also Contr. No. 2, tunnel to P. G. Ligon, Baltimore; No. 3, laying pipe, to Pace Constr. Co., Mountain Trust Bldg., Roanoke, Va.; Lynchburg Foundry Co., Peoples Natl. Bank Bldg., Lynchburg, Va., for pipe.

Wash., Bellingham—Contracts for pipe and fittings for final unit of new high line water system, awarded by City Council. American Cast Iron Pipe Co., Birmingham, Ala., contract at $76,058 for 24-in. sand cast iron pipe and $1,874.70 worth of 4-in. sand cast iron pipe; U. S. Cast Iron Pipe & Foundry Co., Burlington, N. J., contract at $7,960, 12-in. pipe; $13,164, 8-in. pipe, and $7,954 for 6-in. pipe—total cost, $29,087; Rensalaer Valve Co., contract for furnishing 24 valves at $8,160.

Wash., Kelso—J. D. Hanley, Kelso, awarded contract by City Council for improving water works, including 2 m. g. reservoir, 5 miles 4-15 in. mains, etc., at $122,715.

Wash., Seattle—J. F. Shea & Co., 3506 Avalon Way, awarded contract by Board of Public Works for construction of Honey Creek diverting conduit, portion of Cedar River Water System, at $54,894.

Prospective Work

ROADS AND STREETS

Ala., Andalusia—Covington and Crenshaw Counties plan to build 12 mi. road from Andalusia to Searight.

Ariz., Flagstaff—State Engineer W. C. Lefelyre has announced that arrangements have been completed for rebldg. 68 miles Old Trails Hwys.—Flagstaff to Winslow. Est. cost, $300,000.

Cal., Riverside—Plans made for improving portions of Victoria and Dufferin Sts., etc.; 1,203,85[illegible] sq. ft. macadam paving, 400,956 sq. ft. shoulders, 7,399 ft. 10-in. to 30-in. pipe. C. B. Burns, City Clerk.

Cal., Santa Rosa—Sonoma County plans to construct 10 miles Santa Rosa Russian River Hwy., 18 ft. or more, $110,000. E. A. Peugh, County Surveyor.

Fla., Bartow—Polk County, Lake Wales Dist., plans to widen Bartow-Lake Wales Rd., to 19 ft. and build about 30 miles other roads; $750,000 bonds voted. J. D. Raulerson, Clerk.

Fla., Clearwater—City plans expending $250,000 for about 8 miles of additional streets.

Fla., Ormond—Town plans to pave 20 streets to 16 and 18 ft. width and improve water works. Est. cost. abt. $500,000. Election Nov. 4th to vote on $175,000 bonds. Darrell Carnell, Town Zone, Manager.

Fla., Tampa—Hillsborough County Comrs., considering petition for bldg. 22nd Street causeway across Hillsborough Bay, 5 mile road from south end of span to connect with Riverview Rd.; also boulevard along DeSoto Park sec.; also will vote on $750,000 bonds. De Soto Park Dist.

Iowa, Bedford—Resolutions passed for 31 additional blocks of paving for 1925. J. E. Lovell, City Clerk.

Iowa, Indianola—Resolutions passed for paving 18 blocks, resurfacing 12 blocks, widening pavement on 4 blocks; also considering paving Primary Rds. 1 and 24, about 1 mile through City. H. C. Criswell, City Clerk.

Iowa, Hamburg—Contemplate resurfacing about 1 mile old asphalt concrete, 4 blocks of which are 60 ft. wide. F. S. Miller, City Clerk.

Ill., Highland—Prelim. plans being made for grading and hard surfacing 7,000 ft. various streets, 28 ft. $80,000. P. B. Wilson, First Natl. Bank Bldg., Marion, Manager.

Md., Baltimore—City plans election in November to vote on 7,000,000 bonds for paving, bridges and elimination of steam railroad grade crossings.

Mo., St. Louis—City plans to widen to 80 ft. about 10 blocks on Easton Ave. Est. cost, $504,825. J. B. Steiner, Assoc. City Counsellor.

Mich., Lansing—Bond issues in following sums carried at election Sept. 9: $600,000 for paving business streets here and $300,000 for sewer work.

Neb., Omaha—Ordinances passed for St. Impvt. Dists. 2651, 2652, 2657, 2660, 2650, 2663, 2664, 2665, 2666 and 2667. Pave with asph. stone, vit. brick, vit. blk. artif. stone, macadam, creo. wd. blk. or asph. conc. Jas. P. Hoctor, City Clk. Also Ords. passed for St. Impvt. Dists. Nos. 2672, 2669, 2670, 2671, 2673, 2661, 2676, 2679, 2668, 2677 and 2678; paving with asph. stone, vit. brk. vit. brk. blk. artif. stone, macadam, creo. wood blk. or asph. conc. Address City Clk. for detailed information.

N. C., Winston-Salem—City plans to pave with rock, asphalt, sheet asphalt and bitulithic 9 streets.

Okla., Cherokee—Alfalfa County plans to expend $150,000 for highway impvts., including $100,000 to maintain and build 50 miles of roads and $50,000 for 9 bridges. L. C. Bernard, Co.

Oregon—Expenditures totalling $385,400 of forest hwy. funds for constr. of highways within or adjacent to the National forests in Oregon, approved by Secy. of Agriculture.

S. C., Laurens—Laurens County plans 200 miles topsoil rd. Est. cost $400,000. J. F. Jacobs, Clinton, S. C., interested.

Tenn., Chattanooga—Board Public Works appropriated $125,000 for streets and sewers. E. Bass, Comr.

Tenn., Nashville—State Hwy. Dept., Nashville, will receive bids in December to grade and drain 14 roads: 4 mi. Cooke Co., 11 mi., 27 mi. slag—all St. Hwy. No. 9; 3 mi. St. Hwy. 2; 5 mi. bitum. macadam St. Hwy. 2; 5 mi. chert state hwy. 6, Maury Co.; Cannon Co., 7 mi. bitum. macadam St. Hwy. 1; Rutherford Co., 11.66 mi. bitum. mac. St. Hwy. 1; Smith Co., 10.75 mi. bitum. mac. St. Hwy. 24; Bedford Co., 10.50 mi. bitum. mac. St. Hwy. 10; Wayne Co., 16 mi. gravel St. Hwy. 15; Harding Co., 18.8 mi. gravel, St. Hwy. 15; Madison Co., 9.5 mi. St. Hwy. 1; Carroll Co., 12 mi. St. Hwy. 22. J. G. Greveling, St. Hwy. Comr.

Tenn., Knoxville—City Comrs. appropriated $183,000 for paving; $50,000 for maintenance of paved streets. L. Brownlow, City Mgr.

BUYERS' GUIDE

Aerial Tramways.
American Steel & Wire Co.

Air Lift Pumps.
Harris Air Pump Co.

Armor Plates.
Truscon Steel Co.

Asphalt.
Bitoslag Paving Co.
The Barrett Co.
Kentucky Rock Asphalt Co.
Pioneer Asphalt Co.
Standard Oil Co. (Indiana)
The Texas Co.
Uvalde Asphalt Paving Co.
Warren Asphalt Paving Co., The

Asphalt Filler.
The Barrett Co.
Bitoslag Paving Co.
Standard Oil Co. (Indiana)
The Texas Co.
Warren Bros. Co.

Asphalt Floors.
The Barrett Co.
The Texas Co.
Warren Bros. Co.

Asphalt Machinery.
Chausse Oil Burner Co.
Cummer & Son Co., The F. D.

Asphalt Plants.
Austin Machinery Corporation.
Cummer & Son Co., The F. D.
Littleford Brothers.
Warren Bros. Co.

Asphalt Railroad Plants
Cummer & Son Co., The F. D.
Warren Bros. Co.

Asphalt Tools.
Chausse Oil Burner Co.
Littleford Brothers.
Warren Bros. Co.

Asphalt Tool Wagons.
Chausse Oil Burner Co.
Littleford Brothers.

Auto Fire Apparatus.
Kissel Motor Car Co.
International Motor Co.
Pierce-Arrow Motor Car Co.

Automobiles.
Ford Motor Co.

Back Fillers.
Austin Machinery Corporation.
Pawling & Harnischfeger.

Bar Cutters and Benders.
Koehring Co.

Bars, Reinforcing.
Truscon Steel Co.

Binders, Road.
The Barrett Co.
Pioneer Asphalt Co.
Standard Oil Co. (Indiana)
The Texas Co.
Uvalde Asphalt Paving Co.
Warren Bros. Co.

Bitulithic Pavements.
Warren Bros. Co.

Blasting Accessories.
E. I. du Pont de Nemours & Co., Inc.

Blasting Powder.
E. I. du Pont de Nemours & Co., Inc.

Bodies.
Lee Trailer and Body Co.
Littleford Brothers.

Braces, Extension.
Kalamazoo Fdy. & Machine Co.

Brick Rattlers.
Olsen & Co., Tinius.

Brick-Testing Machinery.
Tinius Olsen Testing Mach. Co.

Brick, Paving.
National Paving Brick Mfrs. Assn.

Bridges.
Luten, Daniel B.

Buckets, Dredging, Excavating and Sewer.
Pawling & Harnischfeger.

Buckets, Dumping
Littleford Brothers.
Pawling & Harnischfeger

Cableway Accessories.
Sauerman Bros.

Cableway Excavators.
Sauerman Bros.

Calculators.
Kolesch & Co.

Car Unloaders.
Austin Machinery Corporation.
Heltzel Steel Form & Iron Co.

Castings.
U. S. Cast Iron Pipe & Fdy. Co.

Cast Iron Pipe.
U. S. Cast Iron Pipe & Fdy. Co.

Catchbasins.
Dee Co., Wm. E.
Madison Foundry Co.

Cement Gun Work.
Indiana Gunite & Const. Co.

Cement Testing.
Chicago Paving Laboratory.
Flood & Co., Walter H.
Howard, J. W.
Hunt Co., Robert W.
Indianapolis Paving Laboratory.
Van Trump, Isaac.

Cement Testing Machinery.
Tinius Olsen Testing Mach. Co.

Central Heating Plants.
American District Steam Co.

Chemists, Engineering
Chicago Paving Laboratory.
Dow & Smith.
Flood & Co., Walter H.
Howard, J. W.
Hunt Co., Robert W.
Indianapolis Paving Laboratory.
Van Trump, Isaac.

Chimneys, Concrete.
Truscon Steel Co.

Chimneys, Steel.
Littleford Brothers.

Chloride of Lime.
Pennsylvania Salt Mfg. Co.

Clay Pipe, Vitrified.
Clay Products Assn.

Clay Products.
Clay Products Assn.

Concrete Bridges.
Luten, Daniel B.

Concrete Mixers.
Austin Machinery Corporation.
Koehring Co.
Smith Co., T. L., The

Concrete, Reinforcement.
American Steel & Wire Co.
Truscon Steel Co.

Conduits.
Cannelton Sewer Pipe Co.
Carey Co., Philip, The.
Rosing, Inc., Astrid S.
Truscon Steel Co.

Conduit Rods.
Stewart, W. H.

Consulting Engineers.
Alvord, Burdick & Howson.
Artingstall, Wm.
Brossman, Chas.
Burd & Giffels.
Chicago Paving Laboratory.
City Wastes Disposal Co.
Dow & Smith.
Druar & Milinowski.
Flood, Walter H., & Co.
Howard, J. W.
Hunt Co., Robert W.
Indianapolis Paving Laboratory.
Jones, Sam L.
Kirchoffer, W. G.
Kirschbraun, Lester.
Luten, Daniel B.
Potter, Alexander.
Van Trump, Isaac.
Wells, James P.

Contractors.
City Wastes Disposal Co.
Sullivan, Long & Hagerty.
Warren Bros. Co.

Contractors' Tools and Machinery.
Austin Machinery Corporation.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.
Smith Co., T. L., The

Contractors' Wagons.
Austin Machinery Corporation.
Austin-Western Road Machinery Co.

Conveying Machinery.
Mead-Morrison Mfg. Co.
Pawling & Harnischfeger.
Portable Machinery Co., Inc.
Webster Mfg. Co.

Cranes and Hoists.
Austin Machinery Corporation.
Heltzel Steel Form & Iron Co.
Pawling & Harnischfeger.

Creosote.
The Barrett Co.
Republic Creosoting Co.

Creosoted Wood Block.
(Factory Floors, Bridge Floors)
Republic Creosoting Co.

Crushers, Rock and Ore.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.

Culvert Pipe, Vitrified.
Cannelton Pipe Co.
Dee Clay Mfg. Co., Wm. E.

Culverts.
Austin-Western Road Machinery Co.
Newport Culvert Co.
Truscon Steel Co.

Curb and Gutter Forms.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Curb Bar.
Truscon Steel Co.

Tex., Beaumont—Jefferson County plans to build 3 roads: Sabine Pass to Galveston Co.; portion of rd. from Beaumont to High Island, and road to Sour Lake. Contemplates voting on $1,000,000 bonds. For more detailed information address County Comrs.

Tex., Eagle Pass—Maverick County plans bldg. road thru County to Dimmitt County line. $150,000 bonds voted. $300,000 est. cost, State Hwy. Dept. to pay half.

Tex., Floresville—Wilson County will soon receive bids for 12.12 mi. State Hwy. 81—Bexar Co. line to Old Southerland Springs; 8-in. gravel surf., 4-in. macadam base, 1-in. bitum. top, approx. cost, $223,000. F. E. Hess, Co. Engr.; J. E. Canfield, Co. Judge.

Tex., Goliad—Goliad Co. plans hard surfaced roads. Contemplate voting on $1,000,000 bonds.

Tex., Henrietta—Clay County plans 20 mi. hard surf. road on State Hwy. 50, from Henrietta. Est. cost, $663,000. D. M. Puckett, Co. Engr.; J. F. Vaden, Co. Judge.

Tex., Pearsall—Frio Co. plans 14.83 mi. 18-ft. gravel rd. on State Hwy. 85, from Dilly to Dimmitt Co. line. Est. cost, $170,000. Also plans 100-ft. bridge across Cibolo River. R. E. Killmer, Co. Engr.; Jno. J. Pranglin, Co. Judge.

Tex., San Antonio—Bexar Co. plans 8.8 mi. State Hwy. 3, Castroville Rd.—Medio Creek to Medine Co. line. Est. cost, $149,000. R. E. Kilmer, Actg. Co. Engr.; Augustus McCloskey, Co. Judge.

Tex., Sweetwater—Nolan Co. plans to surface 15.22 mi. of road from Sweetwater to Mitchell Co. line, 18 ft. bitum. on sledged and crushed stone. J. A. Focht, Sweetwater, Engr. $370,000.

Tex., Temple—City plans to expend $170,000 to pave about 38 or 40 blocks.

Tex., Vernon—Wilbarger Co. making plans to grade and surface with rein. conc. 10.09 mi. State Hwy. 5; 18 ft.; $406,000. J. B. Nabors, Co. Engr.

Va., Ft. Myers Hts.—Arlington Co. plans to build 20 mi. of road totaling in cost about $700,000; conc., 16 ft. wide, 1⅝ mi. Wilson Blvd.; 1 mi. Columbia Turnpike; ⅝ mi. Military Rd.; ⅞ mi. Donaldson Rd.; 1¼ mi. Washington Sy.; ⅞ mi. Shelley Rd.; 1¼ mi. Clarendon Ave.; ½ mi. Bingham Rd.; 1 mi. Garrison Rd.; ⅝ mi. Sherman Ave.; bitum. macad., 16 ft. wide; 1⅜ mi. Garrison Rd.; ¼ mi. Ballston Ave.; ½ mi. Fox Rd.; ¼ mi. Arlington Ave.; ¾ mi. Westmoreland St.; waterbound macadam, 16 ft. wide; ½ mi. Wilson Blvd.; ¾ mi. Jefferson St.; special impvts. Wilson Blvd.—Lubber Run to Military Rd. Capt. Talman, Supt. of Arlington Co. Roads.

Va., Portsmouth—Norfolk Co. Comn. of Rds. & Brdgs. contemplates opening 30 ft. rd. from Little Craney Island Rd. to W. Norfolk Rd.; also lay macad. surf. on Ingleside Rd. from Broad Creek Rd. to Princess Anne Turnpike; plans macad. pave. to Carolina Ave.—Princess Anne Rd. to Philpotts Ave.; Caleman Pl. and cindering Georgia Ave.

Va., Portsmouth—Norfolk Co. plans to improve Taylor Rd. connecting Tyre Neck Rd. to Pughsville to Portsmouth-Suffolk Hwy. R. B. Preston, Co. Rd. Engr.

Wash., Tacoma—City Council unanimously voted to include item of $100,000 in 1925 budget to assist in getting perm. paved road from Old Tacamo to the smelter along waterfront. Property owners along the 2¼ mi. waterfront have agreed to pay assessment of $8 per front ft. Assurances also obtained from Nor. Pacific and Milwaukee railroads that each road will put in $100,000 towards project. With City's aid, approx. $400,000 should be available to build the road.

Wash., Wenatchee—State Senator McCauley, Ellensburg, announces plans for paving road betw. Cashmere and mouth of Peshastin from appropriations made in coming legislature.

Wis., Appleton—Paving projects construction thru period of 5 years adopted by City Council: 20 mi., $1,000,000; 5 mi. to be constructed in 1924. $250,000. E. O. Williams, City Clk.

SEWERAGE AND SEWAGE TREATMENT

Cal., Los Angeles—Election may be called Nov. 18th for Metropolitan Sewer Dist. bond issue. Proposed issue may be in neighborhood of $12,000,000.

Cal., Reedley—City planning to discard old sewer system and install new one involving filter beds, beds for pumping purposes and other modern impvts. Application has been made to State Bd. of Health.

Ont., Riverside—Trunk sewer will be laid from sewage disp. plant to intersect. of old and new courses of Little River.

Fla., Bradentown—Whitney Curry, Mayor, in favor of laying several mi. san. sewers, water mains; constructing sewer sys. and street improvements. R. K. VanCamp, City Engr.

Idaho, Coeur D'Alene—City will begin at once to advertise for bids for sewers in Dist. Nos. 47 and 48. Est. cost, $78,000. Neil S. Coventry, City Engr.

Iowa, Vinton—Plans being made for disposal plant. Cons. Engr. M. Tschirgi & Sons, 712 American Trust Bldg., Cedar Rapids. W. E. Gilchrist, City Clk. Est. cost, $50,000.

Iowa, Waterloo—Construction of sewage disposal plant here being considered. Ralph B. Slippy, City Engr.; Chas. C. McKay, City Clk. Est. cost, $400,000.

Ky., Paducah—City considering constr. of lateral sewers connecting with $600,000 trunk line sewer.

La., Amite—$65,000 bonds voted here to install sewer system.

Md., Baltimore—Public Impvt. Comn., allotted to Bernard L. Crozier, Hwys. Engr., $50,000 for draining work in connection with impvt. of Queensberry Ave.—Oaklay Rd. to Belvedere Ave., and $4,200 for water main in same st.

Md., Baltimore—City will have Milton Ruark, Sewerage Engr., design sewage disposal plant to be built at Curtis Bay.

Mich., Benton Harbor—City has authorized considerable sewer work. Bids directed to be asked for and it is understood some of the work will be under way this fall if weather permits. Some sewers are san. and others storm.

Mich., Lansing—$300,000 bonds for sewer extensions voted here.

Neb., Columbus—Will make plans for additional sewer system in east end of city and extensions to old system. Wm. Becker, City Engr.; L. F. Gottschalk, Spcl. Engr.

Ore., Reedsport—Sewer system will be built here in near future. Plans submitted (and accepted by City Council) by D. L. Buckingham, Marshfield. Est. cost of project, $33,000.

S. C., Dillon—$50,000 bonds voted for sewer sys. For detailed information address the Mayor.

Tenn., Mt. Pleasant—City considering issuance of $50,000 bonds for constr. of sewerage system.

Tex., Caldwell—$45,000 bonds voted here for sewer constr.

Va., Clarendon—(Branch of Washington, D. C.) Arlington Co. Bd. of Supvrs. authorized Capt. Jno T. Talman, San. Engr., to make survey for sewer sys.

Wis., Ferndale—Cost of bldg. trunk sewer sys here est. at approximately $20,000. City Engr. directed to prepare estimate for system.

Wis., Birnamwood—Plans approved by State for sewage treatment plant here. Tank 10x24, 6 ft. deep, sludge bed 16x28. Cons. Engr. W. G. Kirchoffer, Madison. Guy VanDoren, City Clk.

Wis., Fond du Lac—City is selecting site for sewage disposal plant; probably east bank of river no. of Scott St. J. F. Hohansee, City Clk.

Wis., Milwaukee—Will receive bids in spring for constr. of new main sewerage system and sewage disposal plant in So. Milwaukee. Est. cost, $40,000. Richard Schauer, City Clk.

WATER SUPPLY AND PURIFICATION

Ariz., Flagstaff—Election will be called in November covering $400,000 water works impvts., including 50,000,000 gal. conc. reservoir; about 15 mi. 14 steel pipe line and other improvements. Surveys and plans completed. Burns-McDonnell Engr. Co., 415 Marsh-Strong Bldg., Los Angeles, Cal., Cons. Engrs.

Cal., Lankershim—$776,000 water bond issue of Mun. Imp. Dist. 27, Lankershim, carried at recent election.

Cal., Long Beach—Clark H. Shaw, Mun. Water Supt., has announced that work will be started at once on last unit of a system of 8 or more municipal pumping plant stations thru Virginia City and adjacent territory. Each station will take

BUYERS' GUIDE

Deep Well Pumps.
Harris Air Pump Co.
Keystone Driller Co.

Drag-Line Excavators.
Austin Machinery Corporation.

Drag Scrapers.
Austin-Western Road Machinery Co.

Drain Tile.
Dee Clay Mfg. Co., W. E.
Rosing, Inc., Astrid S.

Dryers.
Cummer & Son, The F. D.

Dump Cars.
Austin-Western Road Machinery Co.

Dump Wagons.
Austin-Western Road Machinery Co.

Dust Laying Compound.
The Barrett Co.
Standard Oil Co. (Indiana)
The Texas Co.

Dynamite.
E. I. du Pont de Nemours & Co., Inc.

Edge Protector.
Truscon Steel Co.

Electrical Machinery.
Westinghouse Electric & Mfg. Co.

Electrical Wires & Cables.
American Steel & Wire Co.

Elevating Graders.
Austin-Western Road Machinery Co.

Excavating Machinery.
Austin Machinery Corp.
Pawling & Harnischfeger.
Sauerman Bros.
Smith Co., T. L., The

Expansion Joint Compound.
The Barrett Co.
Carey Co., Philip, The
Pioneer Asphalt Co.
Truscon Steel Co.

Explosives.
E. I. du Pont de Nemours & Co., Inc.

Fillers (Paving Joint).
The Barrett Co.
Carey Co., Philip, The
Pioneer Asphalt Co.
The Texas Co.

Fire Brick.
Cannelton Sewer Pipe Co.
Dee Clay Mfg. Co., W. E.

Flue Liners.
Cannelton Sewer Pipe Co.
Dee Clay Mfg. Co., W. E.

Forms, Sidewalks, Curb & Gutter.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Forms, Road.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Gas Pipe.
U. S. Cast Iron Pipe & Fdy. Co.

Gates, Sluice.
Coldwell-Wilcox Co.

Graders.
Austin-Western Road Machinery Co.

Granite Block.
Granite Paving Block Mfrs. Assn. of the U. S., Inc.

Gunite.
Indiana Gunite & Const. Co.

Heaters (Rock and Sand).
Littleford Bros.

Heating Plants, Central.
American District Steam Co.

Heating Wagons (Oil and Tar).
Good Roads Machinery Co., Inc.
Littleford Bros.

Hoists (Concrete, Gasoline and Hand).
Pawling & Harnischfeger.

Hoists, Electric.
Mead-Morrison Mfg. Co.
Pawling & Harnischfeger.

Hoists, Steam.
C. H. & E. Mfg. Co.
Mead-Morrison Mfg. Co.

Hot Mixers.
Austin Machinery Corp.

Inlets (Sewer).
Dee Co., Wm. E.
Madison Foundry Co.

Insulating Material.
The Barrett Co.
Pioneer Asphalt Co.

Joint Fillers (Paving).
The Barrett Co.
Carey Co., Philip, The.
The Texas Company.

Kettles (Portable).
Cummer & Son Co., The F. D.
Good Roads Machinery Co., Inc.
Littleford Brothers.

Manhole Covers.
Madison Foundry Co.
Dee Co., Wm. E.

Mastic.
The Barrett Co.
Pioneer Asphalt Co.

Meter Boxes.
McNutt Meter Box Co.

Mixers, Asphalt.
Austin Machinery Corporation.
Cummer & Sons Co., The F. D.

Mixers, Concrete.
Austin Machinery Corp.
Koehring Co.
T. L. Smith Co.

Motor Fire Apparatus.
Duplex Truck Co.
Federal Motor Truck Co.
Garford Motor Truck Co.
International Motor Co.
Kissel Motor Car Co.
Pierce-Arrow Motor Car Co.

Motor Trucks.
Duplex Truck Co.
Federal Motor Truck Co.
Ford Motor Co.
International Motor Co.
Kissel Motor Car Co.
Pierce-Arrow Motor Car Co.

Motor Truck Flushers, Sprinklers, and Oilers.
Acme Motor Truck Co.
Austin Machinery Corporation.
Duplex Truck Co.
Federal Motor Truck Co.
Garford Motor Truck Co.
The Gramm-Bernstein Motor Truck Co.
International Motor Co.
Kissel Motor Car Co.
Pierce-Arrow Motor Car Co.

Municipal Castings.
Dee Co., Wm. E.
Madison Foundry.

Packing.
Pioneer Asphalt Co.

Paints (Asphalt).
Barrett Co., The
Pioneer Asphalt Co.

Paving Blocks (Creosoted).
The Barrett Co.
Republic Creosoting Co.

Paving Brick.
Murpysboro Paving Brick Co.
National Paving Brick Mfrs. Assn.

Paving Contractors.
Warren Bros. Co.

Paving Joint Compound.
The Barrett Co.
Carey Co., Philip, The
Pioneer Asphalt Co.
The Texas Company.

Paving Joint Filler.
The Barrett Co.
Carey Co., Philip, The.
Pioneer Asphalt Co.
The Texas Company.

Paving Machines.
Austin Machinery Corporation.
Cummer & Son Co., The F. D.
East Iron & Machine Co., The
Warren Bros. Co.

Paving Plants (Asphalt).
Austin Machinery Corporation.
Cummer & Son., The F. D.
East Iron & Machine Co., The
Good Roads Machinery Co., Inc.
Smith Co., T. L., The
Warren Bros. Co.

Pipe Cutters.
W. W. Strickler & Bros.

Pipe Dip and Coatings.
The Barrett Co.
Pioneer Asphalt Co.
The Texas Co.

Pipe Manufacturers.
U. S. Cast Iron Pipe & Fdy. Co.

Pitch Filler.
The Barrett Co.
Warren Bros. Co.

Plows (Rooter and Wing).
Austin-Western Road Mach. Co.

Portable Paving Plants.
Austin Machinery Corporation.
Cummer & Son Co., The F. D.
Good Roads Machinery Co., Inc.
Littleford Brothers.
Warren Bros. Co.

Portable Stone Bins.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.

Powder (Blasting).
E. I. du Pont de Nemours & Co., Inc.

care of approx. 60 acres. First unit will be in Vetter Park and will have capy. of 1,000 gals. per minute. Capt. Burt Harmon, Hydraulic Engr.

Cal., Montecito—Montecito Water Dist. has applied to State Dept. of Public Works for permit to construct tunnel from a point back of summerland to Santa Ynez River.

Cal., Newport Beach—City Engr. Paul E. Kressly, H. W. Hellman Bldg., has completed plans and presented same to City Council for water system in the Corona del Mar section, including a 2,500,000 gal. reservoir pumping station distribution sys. Est. cost, $473,000.

Cal., Ramona—Chamber of Commerce Water Comn. will have survey made to determine feasibility of installing domestic water system. Water would be pumped from Santa Maria River into reservoir in the hills. Est. cost, $50,000.

Cal., San Francisco—East Bay Dist. has selected Mokelumne Water source. Board of Engrs. recently completed survey of the projects. The selection, made by Arthur P. Davis, Chf. Engr. Utility Dist., Gen. Geo. W. Goethals and Wm. Mulholland, immediately ratified by the District's Board of Directors at special meeting. Est. cost of Mokelumne proj., $35,000,000, with additional $4,000,000 for interest charges during period of constr. East Day citizens will vote on $39,000,000 bond issue Nov. 4 to finance development of water supply.

Cal., So. Pasadena—Bond election for unified water main sys. is under consideration by City Trustees.

Ont., East London—Utilities Board of London considering equipping pumping station in East London to handle supply of water from wells. It is planned, also, to drill additional wells. W. B. Near, Engr., London, Ont.

Ont., Exeter—Water mains in Huron Street and Lake Rd. are to be extended. Town Council is interested in prices on 4-in. mains.

Fla., Miami Beach—$125,000 bonds voted here for water main extensions; $5,000 for additional fire equipment; $25,000 for san. dept., $7,000 for streets and sewers and $15,000 for shop and storage room.

Ind., Montezuma—Company formed for constr. of water works system here. Ralph Johnson, Clyde Brown and Edw. Hancock placed in charge of a program whics incudes constr. of plant and distribution system. Est. cost. $40,000.

Iowa, Fairfield—Resolution adopted for constr. of additional water works reservoir. Geo C. Woods, City Clk.

Ky., Blackley—Dr. G. Ison and associates will erect water works here. Est. cost, $20,000.

Ky., Jackson—Plans being prepared by Engr. A. B. Hargis, Jellico, Tenn., for new municipal water works system to be installed at Jackson; will be equipped with electrically operated pumping equipment.

Md., Annapolis—Abel Wolman, Chf. Engr. State Board of Health, has plans for constr. of water filtration sys., in Annapolis and enlargement or distribution system. Est. cost about $100,000. Mr. Wilman will also be in charge of constr. of water, sewer and sewage disposal plant at Mt. Wilson Sanitarium, authorized by State Dept. of Health, Baltimore (360 Eutaw Place).

Minn., Little Falls—Election Oct. 29th to vote on $100,000 bond issue for impvt. and constr. of water works system. Andrew Johnson, City Clk.

Miss., Meridian—City has begun constr. work on reservoir for water works. Est. cost, $50,000.

Mo., Aurora—Lawrence Co. Water, Light and Cold Storage Co., will increase capital from $250,000 to $450,000; will extend and improve property and purchase Billings Light, Power and Water Co., and extend line to Republic, Mo.

Mo., Columbia—City Council has approved purchase of two 400-h. p. boilers, centrif. pump, stoker and turbine. Est. cost, $26,532.

Mo., Higginsville—City voted $100,000 bonds for lake water works system; lake to be located east of Higginsville (Capy. 170,000,000 gals.); will also erect standpipe in City with capy. of 100,000 gals. $19,000 bonds also voted for sewer extensions. E. T. Archer & Co., Kansas City, Cons. Engr.

Mo., Marshfild—Marshfield is having plans and estimates prepared by Gantt-Baker Engr. Co., First Natl. Bank Bldg., Oklahoma City, Okla., for water works system.

N. C., Asheville—City Comrs. authorized bond issue of $500,000 for extensions to water works system, consisting of construction of 10,000 gal. distributing reservoir and an impounding reservoir on Bee Tree with capy. of 180,000,000 gals. water. Frank L. Conder, Comr. of Pub. Wks.

N. C., Aulander—$95,000 bonds voted for installation of water and sewerage systems.

N. C., Charlotte—City Comrs. have authorized issuance of $1,420,000 bonds for water, sewer, street and municipal bldgs.

N. C., Greensboro—City has authorized issuance of $200,000 bonds for extension of water system and $100,000 for san. sewerage system. P. C. Painter, City Mgr.

N. C., Mt. Holly—Town will expend $80,000 for water works extensions; will construct 1,000,000 gal. filteration plant, mains, etc.; 5,000,000 gal. reservoir. J. W. Holland, Clk.; Carolina Engr. Co., Charlotte, N. C., Engrs.

N. C., Silver City—Town has retained Spoon and Lewis, Cons. Engrs., American Bank Bldg., Greensboro, N. C., to prepare plans for water and sewerage systems. Bids will probably be called for in about 60 days. $75,000 bond issue available.

Okla., Blackwell—City considering construction of $70,000 water and sewerage system. May call election to vote on bonds.

Okla., Clinton—City will expend $80,000 for construction of 6 wells and water mains. B. M. Hart, Engr., Oklahoma City.

Okla., Durant—City will vote in about 30 days on $50,000 bonds for constr. of water works sys.

Okla., Idabel—City will construct water works and supply system; also filteration plant. V. V. Long & Co., Engrs., Colcord Bldg., Okla. City, Okla.

Okla., Morrison—H. G. Olmsted & Co., Engrs., 2230 W. 19th St., Oklahoma City, preparing plans for complete water works and electrical plant.

Ore., Portland—Report on proposed high pressure water system for congested area of City made by Ernest C. Willard, Cons. Engr., shows that such a sys. to be used exclusively for fire-fighting purposes would require bond issue of $1,426,000 and total of $165,744 year for operating expenses. Report outlines six projects for high pressure systems in bus. area on East Side and 3 projects for business section of West Side.

S. C., Greenville—Water Comn. contemplates developing gravity water supply from Saluda Mountains to cost approx. $2,000,000; prelim. surveys completed and tentative plans made. J. L. Ludlow, Cons. Engr., Winston-Salem, N. C.

S. C., Spartanburg—$1,350,000 bonds voted to construct water wks. plant. J. J. Floyd, Mayor.

Tenn., Knoxville—City will vote on $2,220,000 bonds for constr. of water wks. system.

Tenn., Nashville—Election Nov. 4th to vote here on $3,000,000 bonds for water wks system.

Tex., Port Lavaca—City considering voting on $45,000 bonds for water works plant.

Tex., Grapevine—$60,000 bonds voted to erect water works plant here. Address the Mayor.

Va., Amherst—Election Nov. 4 to vote on $79,000 bonds for water, light and power. L. H. Schrader, Clerk.

Wash., Port Angeles—Final surveys completed on $625,000 water wks. impvt. project here. Plans and specfs. will probably be ready within next two months. Burns and McDonnell Engrs. Co., 402 Interstate Bldg., Kansas City, Mo., and 415 Marsh-Strong Bldg., Los Angeles, Cal.

Wash., Shelton—Prelim. surveys completed on $150,000 water works impvt. project for Shelton. Burns and McDonnell Engrg. Co., 402 Interstate Bldg., K. C., Mo., and Marsh-Strong Bldg., Los Angeles, Cal.

Wash., Spokane—Plans being prepared by Water Superintendent A. Lindsay for following equipt., and works: pumping plant, $415,000; pumping plant addition, $165,000; new reservoir on north side and replacement of mains, $250,000.

W. Va., Parkersburg—City considering voting Nov. 4th on $250,000 bonds for water impvt. bonds.

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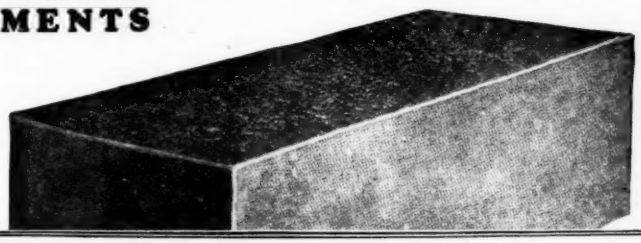

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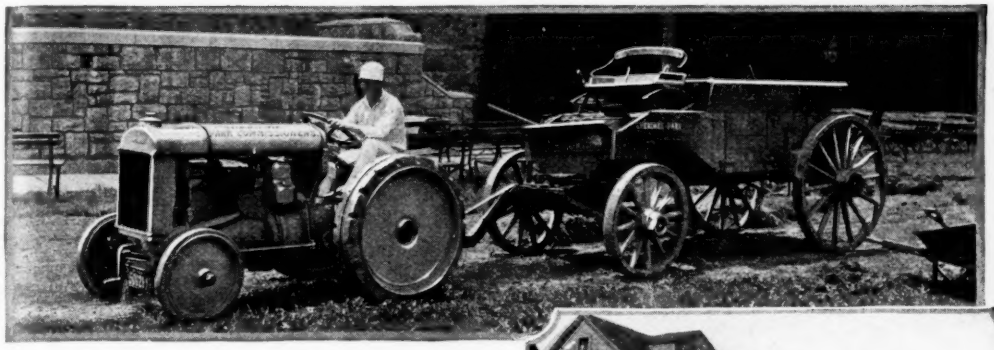

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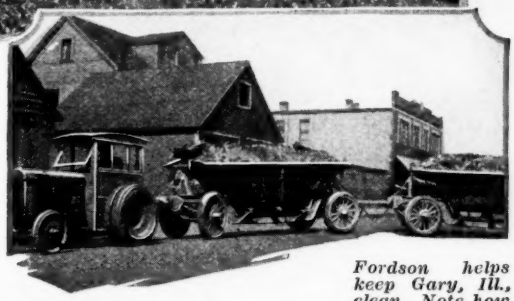

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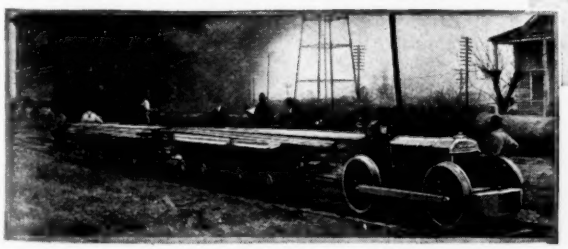

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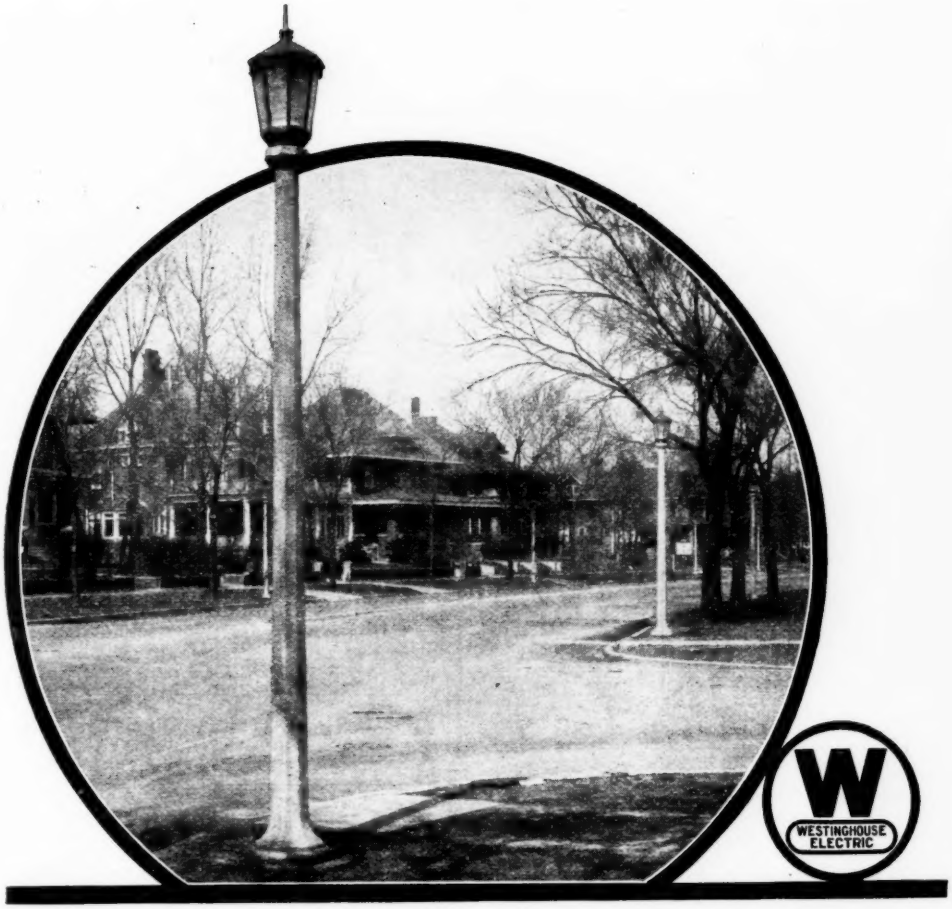

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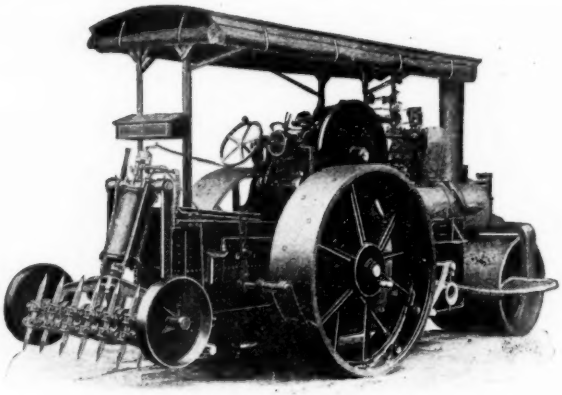

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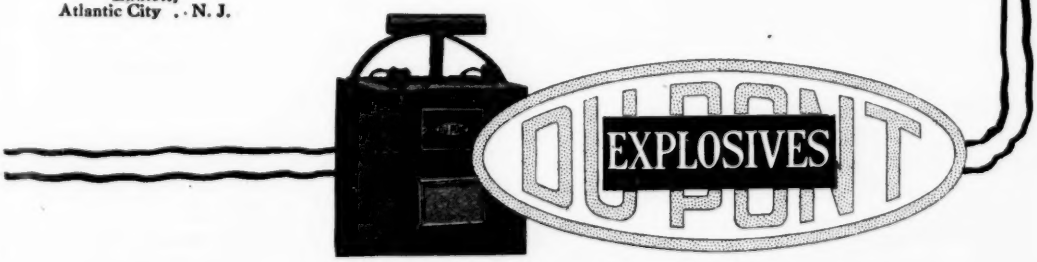

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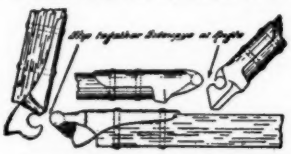

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THE ROAD SHOW

As previously announced in this journal, the annual Road Show will be held in Chicago January 5-9, 1925. This is ten days earlier than the show is generally held. It has been the custom in recent years, for the publishers of this magazine to use the January issue as the Road Show issue, but because of the show following so soon after the holiday season it has been decided this year to use the December, 1924, issue as the one to display at the Road Show in January. Those who have articles they wish to submit for publication in the Road Show number, and those who wish to advertise in that number, should have manuscripts and advertising copy in this office not later than December 15 to insure proper consideration.

It is expected that the coming Road Show will be the largest and most successful ever held. Not only does this show become more important each year, from the standpoint of those who attend it to inspect equipment and to attend the sessions of the American Road Builders' Association, but more and more firms are seeking exhibition space from year to year. There is little doubt that the show of 1925 will be the biggest and best ever held.

This is one show and one convention that it is decidedly worth while to attend. Any man is justified in making a trip half way across the continent to attend the show and convention. Thousands of people come great distances each year to attend these meetings, and the feature that appeals most to many people is the opportunity thus provided to meet old acquaintances from various parts of the country. The occasion is virtually the annual roundup of everybody interested in road building.

FUTURE HIGHWAY EXPENDITURES

When road builders get together they often speculate on how long the present era of road building is likely to continue. The feeling of many is that this is the golden age of the road builder and that at some time in the fairly near future road building revenues will begin to decline The probabilites are, however, that these revenues will continue at their present level, if they are not greatly increased.

A few years ago the State of Illinois passed a sixty-million dollar bond issue for paving portions of the State highway system. Shortly after this the editor happened to be in the office of a prominent Chicago contractor. This contractor expressed a determination to get his share of the work to be done under this bond issue. He was quite sure such an opportunity would never come again, that no state could be expected ever to duplicate, much less exceed, this great expenditure for highways. On November 4, of this year, however, as is well known, the people of Illinois voted a second bond issue for highways, this time for one hundred million dollars. Thus the people of that state were willing to spend vastly more than the experienced road contractor had anticipated.

The motor vehicle, of course, has become a great source of revenue for road construction and maintenance. Inasmuch as the taxes imposed by government on the motor vehicle owner are insignificant compared to the taxation he imposes on himself voluntarily for the purchase, upkeep and operation of his vehicle, and as the operation of his vehicle leads to many expenditures of public funds for other purposes than road and street construction and maintenance, it seems likely that motor vehicle taxation will increase at fairly frequent intervals until it becomes considerable higher than it is today. This thought alone should serve to reasure those who are skeptical about keeping highway funds up to their present level.

"WHY A FINAL NOTE PROLONG?"

There has been much desirable co-operation between privately owned utilities furnishing a variety of services to the public; that is, through associations, water, electric light, gas, telephone, electric railway and other interests have cooperated in presenting their case to the public. Much of this co-operation has been highly desirable and in the interest of the public, quite as much as in the interest of the utilities. The point may be reached, however, at which some question should be raised as to the length other utilities should go in giving aid and upport to some one utility that may be under fire for the moment.

The thought has come to us especially in connection with developments in the transportation field. Being interested in road and street construction it naturally follows that this magazine should become interested in road and street traffic, and in the classes of vehicles operated for hire over roads and streets, namely, the

common carrier trucks and buses. These vehicles have come into competition with urban and interurban electric railways. Some damage to the railways is bound to result from this competition. While the electric railway industry, as a whole, will be able to adjust itself to these conditions, some lines will go out of existence; in fact, some have already suspended operations.

Some of the familiar utility theories are being worked overtime in support of the electric railway that is being hard pressed to make ends meet. Some tendency has been noted for utility men in other fields to go out of their way to try to bolster up these waning utilities. It may be questioned if this is wise. The public is showing some impatience with some of the generally accepted valuation and rate-making theories, and utility men will do well to consider seriously whether it is wise to press too hard the claim for a fair return on the investment of the utility that the public well knows is obsolescent. Such support probably comes from the impulse of utility men to hang together, which is commendable and understandable, but it is doubtful if it is wise for a water utility, for example, to interest itself too much in the preservation of a different type of utility that in some cases, at least, is on its way out.

METERING SMALL TOWN WATER SUPPLIES

By F. V. Fields, Superintendent Water and Light Plant, Mooresville, N. C.

The question in hand could be easily answered if it did not specify small town; with the mass of statistics that are available as to the consumption of water in metered and unmetered cities, there can be little doubt in the mind of water works men as to the value of 100 per cent metering for cities. If the city exists whose records show that the cost of its water supply has been increased by metering, these records have been well concealed.

There is, between the small town water supply system and that of the city, a certain analogy, which can give the small town a lesson that many cities have learned at great expense and it will be worth while to consider a few of the outstanding features of such lessons. For example take the city of Chicago, an extremely bad example of a partially metered water supply. The consumption of water in Chicago in 1923 was 294 billion gallons; 93 billion gallons were metered; that is about 30 per cent and this 30 per cent brought in $5,500,000, approximately, while the remaining 70 per cent brought in $3,500,000 approximately. And where the consumption per day should be 150 gallons per capita, it is 275, with a peak load of 400. There are many cities that have cut their consumption in half by 100 per cent metering. There are many small towns of today which will grow into cities and by adopting 100 per cent metering as small towns they will save millions of dollars. It is easier to put in 100 per cent metering in the small town than in the city; the political government of Chicago has failed for 20 years to take action on the recommendation of the chief engineer to provide for 100 per cent metering.

But considering the small town as such, will 100 per cent metering pay as an investment? Assuming that it will not and that only wasteful customers and large users will be metered, who shall decide which is the wasteful customer? If meters are installed at the request of the customer, it will be the careful, saving man who will insist on having a meter, so that unless authority is given to the water department to place a meter on any customer, there is no need for metering whatever. The customer who asks for a meter expects to reduce his own bill.

As an investment a meter must save enough water to pay for depreciation and interest on the investment. The investment will be about $15 per dwelling service. Considering the life of the meter as 15 to 20 years, the depreciation will be about 6 per cent and for a return of 6 per cent, a total of 12 per cent or $1.80 must be realized each year per meter. The average water rate for North Carolina is 30c per 1,000 gallon, which calls for a saving of 6,000 gallon per meter, only 500 gallon per month. One or two leaky fixtures, a few minutes a day with the hose, letting the water run to prevent freezing, any of these and many other wasteful practices will far exceed the 500 gallon per month needed to insure a return on the meter. Furthermore the economical water user is not required to pay a proportion of the additional expense entailed by the wasteful habits of his neighbors.

The foregoing paper by Mr. Fields was presented before the recent annual meeting of the North Carolina Section of the American Water Works Association.

THE TRIUMPH OF AN UNHAMPERED MIND

(Editor's Note: Coming, as it does, from the *Wall Street Journal*, the following analysis of Henry Ford and his success, is especially noteworthy. Ford literature has become voluminous and in all that vast volume we have seen nothing that remotely approaches the following as a piece of inspirational writing for the general reader. For years Mr. Ford's early finish was gleefully predicted not only by the great money masters but also by the latest recruit in the mighty hosts selling competing makes of motor vehicles, and by thousands of others between these extremes. Yet despite this unparalleled "knocking," in which great newspapers joined, we have all seen Mr. Ford marching steadily onward from one success to another. While his like may never be seen again it is quite possible that a proper understanding of him may do much to loosen the fetters that have long bound the human mind and have made it the slave of passion and prejudice.)

When Henry Ford comes to be adequately understood it is likely that the secret of his amazing career will be found to lie less in the ordinary conception of genius than in the unparalleled freedom of his mind—and spirit. *Almost all men, even when they consciously endeavor to give imagination a free rein, are hampered by preconceptions which they like to dignify with the name of principles.* Henry Ford has never had any difficulty in discarding familiar ideas, whether they happened to be other men's or his own.

That is not to say that he has always been free from prejudices, but these have afflicted him only momentarily. If some still remain to him, it is safe to say that he is at this moment preparing to throw them overboard. He would be the first, doubtless, to admit that he has made mistakes; the extraordinary openness of his mind to new lights has enabled him to correct his errors or abandon false premises before much harm was done.

Today Henry Ford is building electric locomotives for his railroad the like of which have never existed and, for the matter of that, may never exist elsewhere than on his Detroit, Toledo & Ironton. That they promise a genuine contribution to the progress of transportation engineering even the staid conservatives of the electrical and mechanical sciences agree. At the beginning of his career as a railroad manager Mr. Ford insulted every instinct of trained railroad men by announcing that he would seek smaller units of lading, power and movement, reversing the settled effort of railroading for a generation. Yet these new locomotives are to have a greater tractive power than most steam freight locomotives, revealing that Mr. Ford will seek greater instead of smaller train-loads.

Evidently the prince of amateurs is not above learning all he can from the very professionals he has so often affected to despise. His mind expands with years and success. Of too few Americans can that be said. The lamentable tendency of human nature is, as it grows in achievement, likewise to grow in self-complacency. It is not necessary, as so many suppose, to be either pro-Ford or anti-Ford, but it is as desirable to recognize his unique quality as it is to think. Ford is one of the few American thinkers who knows how to get out of his own light. His competitors and critics are often themselves their own chief obstruction.

ACTIVATED SLUDGE PLANT AT LODI, CALIFORNIA

By L. F. Barzellotti, City Engineer, Lodi, California

If I were to formulate a definition of progress on the basis of what has been achieved in every field of human endeavor during this first quarter of the twentieth century, I would say that it consists of a keener appreciation of the supreme gift of life, of a determined attempt to eliminate any element tending to its destruction, and of a constant effort to increase its comfort, its pleasure, and, possibly, its duration. Congestion of population, higher standards of living, and a continuous advance in humanitarian feeling have stimulated scientific development for the accommodation of the needs which have been created for better homes, better educational facilities, better water supplies, better streets, better lights, quicker and easier transportation, and, particularly, for all those activities which are more intimately connected with public health and the disposal of waste.

Obviously the civil engineer, who has dedicated his time and knowledge to the study of all matters pertaining to the betterment of cities and communities at large, is called upon to plan and put into

effect the wanted improvement; and, of all problems arising from his work, the disposal of sewage is, beyond doubt, the most important and at the same time the most difficult to solve.

How the City of Lodi has solved this problem, a description of the plant built for such a purpose, together with detailed information about its equipment, cost and operation, forms the subject of this article.

Special Features of Plant

Although I am satisfied that everybody is more or less familiar with the principle on which the reduction of sewage is based, I think that a brief description and explanation of the same will not come amiss and will make it easier to understand some special features of the Lodi plant.

In any city or town, independently from its size, the sewage consists of the refuse of animal and vegetable matter coming from dwellings, business places and industrial plants; its accumulation is a nuisance on account of its offensive odor and a menace to public health on account of its capacity as a carrier and breeder of germs of all kinds of disease. Knowing that matter can not be destroyed but only physically and chemically changed; knowing that these changes in animal and vegetable matter are mostly effected through the parallel processes of fermentation and putrefaction, and these two phenomena can not take place without the presence of air, it was logical to assume that air contact must be the basis for the treatment of sewage and its reduction from a turbid, offensive and dangerous fluid to clear water.

Principles Are Simple

That this is true is further proven by the fact that meat, vegetables and fruit can be preserved in perfect condition if put into containers absolutely free from air and so sealed as not to allow any air to reach the food stuff with which they have been filled. So, based on the principle of air contact, experimenting has been going on for the last 20 years or more, causing the construction of disposal plants differing from each other only in the quantity of air mixed with the sewage, and in the way of obtaining such mixture, and resulting either in complete failures or partial successes.

Out of these experiments, however, one very important fact was thoroughly demonstrated, namely that sewage reduction can be satisfactorily effected only by promoting the life and propagation of the microorganisms which can be fed by that part of the sewage that is called "sludge"; and also that this same sludge must be constantly "active," which means that it must be always mixed with enough air to insure full bacterial development. This fact being unquestionably established, means came to be devised to inject artificially into the sewage the wanted amount of air, and the perfected system was called "the activated sludge method."

Action of Oxygen

From these premises it follows evidently that, in order to obtain satisfactory results, every particle of sewage, as nearly as it is physically possible to do it, must get in contact with the air and remain in that contact a sufficient length of time, if we want the bacteria to develop properly and do efficient work. Thus far the best method to inject air into the sewage has proved to be by the air compressor, although other means have been devised to obtain the same result, but I am not prepared to say whether or not they were successful.

The Lodi sewage disposal plant is of the activated sludge type, and consists of a building housing the machinery, of four aerating tanks, two clarifying tanks with two return channels for the reaeration of the sludge settled at the bottom of the clarifiers, of a chlorination tank, a chemical laboratory and a cottage for the accommodation of the operator or superintendent.

The equipment consists of one Dorr screen to separate solids extraneous to the sewage proper; of an elevator to take up the screenings; of three turbine pumps having a capacity of 1,000 gals. per minute; of two air compressors having a capacity of 450 cu. ft., each run by two 30-horsepower motors; of one large air compressor having a capacity of 1,400 cu. ft. per minute and run by a 100-horsepower motor; of two Dorrco clarifiers consisting of four arms revolving at the rate of one revolution every ten minutes around the bottom of each clarifying tank and sweeping the sludge accumulating there to the outlet provided for this purpose at the center of the funnel-shaped bottom of the tanks, and of a chlorinator housed at the inlet for the effluent into the chlorination tank. The aerating tanks are equipped with removable concrete containers set 4 ft. from center to center and accommodating the

filtro-plates through which the air is forced at a pressure of 10 lbs. to the square inch into the sewage.

The same containers and filtro-plates are provided in the returning channels through which the sludge accumulating in the bottom of the clarifiers is taken back to the inlet of the aeration tanks. These filtro-plates, 12 ins. square and 1 in. thick, are made of a porous material, and cause the air to be divided in a very fine spray when working itself through the liquid mass of the sewage at the named pressure of 10 lbs. to the square inch which keeps it continuously moving.

Capacity Double Present Needs

The capacity of the plant is two million gallons daily and intended to accomodate a city from fifteen to twenty thousand inhabitants or about double the present population of Lodi, and its cost, in round figures was $130,000; this includes the laboratory and the cottage for the operator or superintendent. The personnel of the plant consists of the operator or superintendent at a salary of $150 per month with rent, water and lights free; of one night man and one day man at a salary of $125 per month each. The power used to run the plants, including the pumping of water from the local well, lights and electrical appliances in the laboratory and cottage, averages $6.50 per day.

Aside from the care for the machinery, the main points in the operation of the plant are, first, watching the sludge constantly and wasting its surplus when needed to make sure that it will not become septic, and, second, watching the effluent and testing its purity three times daily by ascertaining the amount of oxygen dissolved in the same.

The sludge is to the sewage what yeast is to bread; if the sludge becomes inactive no oxygen will be shown in the effluent; a good effient must show between 2 and 4 per cent of dissolved oxygen; if over-saturation appears, more air than necessary is used, and some of the compressors may be shut down; hence the importance of regular oxygen tests, both from a sanitary and an economical point of view.

Bacteria Tests

Once or twice a week bacteria tests are taken by incubating colonies on agar media, and a monthly report showing all the above-mentioned data together with record of flow, kilowatt hours of electricity used, percentage of screenings and of moisture of the sludge, are sent to the State Board of Health by request of the head of that department.

The sewage was emptied into the finished plant and the power turned on the 5th of November, 1923; and from that date the effluent has always been as clear as drinking water. During all this time there has never been any change or trouble; there has never been any nuisance from offensive odors, and what is more, according to a statement of the Director of the State Board of Health, this is the first sewage disposal plant which has successfully handled cannery refuse. In a spirit of fairness and truthfulness, I want to mention here, before closing, the name of Mr. Hyde F. Smith, the consulting engineer, who with his thorough knowledge and experience and consequent wise planning, made not only a success of the Lodi plant but also demonstrated that sewage treatment and its complete reduction by the activated sludge system has come out of the experimental stage to become an accomplished fact.

The foregoing paper by Mr. Barzellotti was presented before the 1924 meeting of the League of California Municipalities.

EXPERIENCE WITH CHEMICAL DRY FEEDERS AT GASTONIA, N. C.

By C. E. Rhyne, Superintendent Water and Light Department, Gastonia, N. C.

When Gastonia built its new filter plant several years ago we did not build a chemical house but converted a part of the old filter plant building into one, and in doing so we experienced trouble in several different ways.

Troubles Experienced

1. We did not have room above the dry feed machines to erect the storage hoppers furnished with the machines and had to build a hopper holding around a half bushel to use instead.

2. Due to the location of the chemical house and the Venturi meter tubes, we had to build about 200 ft. of chemical feed line to connect with the incoming raw water line. This line was built of Class B, 4-in. cast-iron bell and spigot pipe using 4-in. tees under each feeder machine.

3. We intended using raw water to dissolve the chemical but due to the present floor elevation we were unable to do

so and had to use filtered water instead, which required around 18,000 gals. per day of 24 hours. This service is metered.

The Dry Feed Machines

The dry feed machines are of the screw feed type employing an adjustable pawl and ratchet for varying the quantity fed, the feed screw passing through an orifice or a cutting plate directly under a sheet metal storage hopper. The rotation of the screw is intermittent, that is, it varies in accordance with the amount of teeth engaged on the ratchet by the pawl. A stripper rotating at a much higher speed picks up the chemicals as discharged from the screw and feeds these in a constant stream into the dissolving hopper. In addition to the pawl and ratchet rate varying mechanism, there are also furnished gears for providing two speeds, the minimum speed being used for low feeds and the maximum speed being used for high rates of feed.

The machines are in duplicate and designed to feed either alum or lime. They are operated by a half horsepower electric motor, the speed of which is reduced by a fully-encased worm gear, this worm gear being in turn connected to the two speed gears driving the feed screw. The entire mechanism of these machines is mounted on a suitable cast-iron bed plate. The minimum capacity of these machines is 25 lbs. per day each and the maximum capacity 2,500 lbs. per day each. These machines were furnished by the Roberts Filter Mfg. Company of Darby, Pa.

All chemicals are bought in barrels and elevated to the feed platform as needed by a chain hoist. The small hoppers on the machines are filled direct from the barrels by using a small grocer's scoop. With a plant of our size using from 125 to 200 lbs. of chemical per day, we get better results by using the smaller hoppers, as with the large hoppers they would hold around two days' supply and the operators would neglect attending the machines as they should. Feeder machines are like any other piece of machinery—they require a certain amount of care and attention to give service.

Troubles with Machines

We experienced some trouble with these machines at first in having the feed screw race and empty the machine in a very short time, giving the water an overdose of chemical, which caused serious trouble. After a close check on these machines we found this was caused by the chemical forming an arch or hollowing out around the feed screw, releasing the pressure on it and causing it to revolve at the same rate of speed as the stripper. In these machines the feed screw is mounted on the stripper shaft in the same manner as a tight and loose pulley are mounted and when the back pressure or friction caused by the chemical is removed the feed screw will revolve at the same rate of speed as the stripper. Don't think this trouble ever occurs when using the hoppers furnished with the machines; that is, if they are kept near full, for I am sure the weight of the chemical would prevent an arch forming. We overcame this trouble by giving the machines a little closer attention and keeping the chemical pushed down firm around the feed screw with a small tamp made from a broom handle.

After 2½ years' service we had to replace one of the 4-in. cast-iron tees in our solution feed line that was eaten up by the solution. This tee was directly under one of the dry feed machines and used to catch the solution from the dissolving hopper. The solution had a drop of 12 ins. from the hopper to the bottom of the tee and where this occurred a hole 3 ins. in diameter was eaten through. We made a careful inspection of the line and found it in good condition.

Dry Feed Better Than Solution Feed

The dry feed methods are superior to the solution feed as they are much cleaner, require less labor and time to operate and less worry from clogged solution lines, which always occur in the night. With the various makes and types of dry feed machines now on the market, I feel sure that the solution feed method will soon be a thing of the past in all size filter plants.

The foregoing paper by Mr. Rhyne was presented at the annual meeting of the North Carolina Section of the American Water Works Association at Charlotte, N. C., Nov. 11-13, 1924.

DISCUSSIONS OF IMPORTANT PRINCIPLES OF BRICK PAVEMENT DESIGN

To the Editor:

There appears in your October (1924) issue, over the name of Mr. Maurice B. Greenough, a very interesting discussion of my article entitled "Important Principles of Brick Pavement Design," published in the August issue. In his dis-

cussion, Mr. Greenough stresses several points which may very properly be emphasized, and I fully appreciate the friendly spirit of his comments.

Mr. Greenough makes reference to Florida base conditions and points out the fact that an expensive foundation is unnecessary in such cases. He also strongly urges a careful study of local conditions in the design of brick pavements, particularly in the design of the foundation. He further points out the important fact that the typical designs as recommended in my article would not be economical under Florida conditions.

In reply, it is desired to state that Mr. Greenough has very properly stressed the important matter of the significance of local conditions in the design of the foundation. As a matter of fact, my article considered the subject of brick pavement design somewhat broadly, and did not discuss the foundation in as much detail as might have been desired. However, reference was had to the significance of local conditions in several paragraphs as follows:

"The depth of brick pavement foundation, and the nature and character thereof, are dependent upon the subgrade conditions and the weight and character of the loads to be supported and distributed."

"Where the natural soil has a high bearing value, or the loads are not excessive, the foundation may be of minimum thickness. However, when it has been determined that the bearing value of the natural soil or subgrade is *uncertain and irregular*, that it is subject to substantial variations in elevation due to frost, moisture content, settlement or other causes, it is quite imperative that the foundation be so designed and constructed that it will have (a) sufficient strength to resist crushing, (b) to receive and distribute the weight and shock of traffic, (c) to bridge over soft places in the subgrade, (d) and to support the wearing surface in its true position."

Again it is desired to point out in the typical cross sections proposed in my article, on pages 58 and 59, that the weight of reinforcement should depend on local conditions.

Mr. Greenough has apparently failed to distinguish in his discussion of my foundation design, between the "typical" cross sections which I propose, and a "standard" cross section which he assumes I propose. The difference is quite readily apparent. In considering brick pavement design nationally rather than locally, it of course would hardly be proper to propose a "standard" design.

Regarding the comparative cost of a reinforced concrete foundation and a plain concrete, my experience indicates that for typical conditions, where 5 to 7 ins. of concrete would ordinarily be required in the foundation, equivalent strength may be secured by the construction of a 4-in. concrete foundation, reinforcing the same with steel bars or fabric equivalent in cost to about 1 to 1½ ins. of concrete, depending on conditions.

The whole purpose of the reinforcement is to secure a given strength in the foundation at a reduced cost, just as in the design and construction of other engineering structures; and where local conditions and prices do not permit such economical use of reinforcement, it should not be employed. In general, however, considering the saving possible in earth excavation due to less thickness of concrete foundation, and due to the economy of reinforced concrete over plain, the typical design will be found entirely practicable. Mr. Greenough has so strongly emphasized the Florida conditions that his illustration might almost be termed "provincial," for as a matter of fact it is in no sense "typical."

Mr. Greenough very correctly states that the construction of the 4 and 3½-in. brick wearing surface is on the decline and that the construction of 3 and 2½-in. wearing surfaces is in the ascendency. He also points out that Seabreeze, Florida, is laying 60,000 sq. yds. of 2⅝-in. brick on sand with sand filler, thus supporting the following statement which appeared in my article:

"The demonstrated durability and toughness of brick as a paving material justifies the wider use of a paving brick having a thickness of not to exceed 2½ ins."

In conclusion, I desire to say quite frankly that Mr. Greenough has brought out in his discussion a number of significant points, and because of his knowledge and experience in this particular field, they are worthy of most thoughtful attention. In considering a "typical" brick pavement section, it is very essential to bear in mind, as pointed out by Mr. Greenough, that "there are too many gravel bases, there are too many crushed stone bases, there are too many reconstructed macadam bases beneath brick

pavements to deny such bases a place in the economic scheme of brick pavement design."

Very truly yours,
Willis D. P. Warren,
Of Holbrook, Warren & Van Praag, Consulting Engineers, Decatur, Ill.,
Nov. 8, 1924.

Improving the Subgrade

To the Editor:

I have been reading with interest W. D. P. Warren's discussion of brick pavement design in your August (1924) issue and M. B. Greenough's letter pertaining to the same, in the October issue.

From the frequent reference to the necessity of the foundation (artificial, as Mr. Greenough names it) bridging soft subgrade areas, it would seem that Mr. Warren is accepting as an unavoidable nuisance what is rapidly coming to be more and more regarded as bad practice, viz., taking the subgrade as you find it regardless of its supporting power and building thereupon an expensive pavement surface, usually upon a likewise expensive intermediate structure (the foundation), with no effort to correct this inherent weakness, but rather with very elaborate and therefore expensive efforts to circumvent the certain outcome of such weakness in the pavement structure alone.

In the final analysis, any pavement is primarily a wearing surface, or more properly, a traffic floor. If we did not have the traffic we would not need the pavement. It is true that such surfacing as may be selected usually carries with it some sort of intermediate course, of one of a number of types and of also various design as to thickness, etc. This is done not because the surfacing needs some particular type of foundation but because the subgrade is considered inadequate to support the loads transmitted through the surfacing medium.

Granting that instances will arise when it is probably too much of a job entirely to rectify the shortcomings of the subgrade, it is yet true that paving engineers have lately fallen too generally into the bad habit of accepting what is dealt them in the way of subgrade and instead of going to the seat of the trouble, have endeavored to fortify against this attack from beneath by constantly increasing the overlying armor plate. To date no consistent success is noticeable.

In Mr. Warren's own city (Decatur, Ill.), it has long been the practice to lay 5 ins. of 1:3:6 plain concrete base where new foundation is required except in very few instances where 6 ins. was specified to meet an extraordinary local condition. In fact, one of the most important thoroughfares in the city is laid on a 4-in. base. Foundation failures are unknown. The answer, of course, is "subgrade."

In Quincy, Ill., where an extensive "Black Base" program is rapidly nearing completion, soft spots in the subgrade are not permitted to remain soft; they are completely removed. A short time ago, Professor Neel (Chief Engineer of the Georgia State Highway Department), in discussing this question, advised me of their practice of providing a layer of gravel or macadam on all subgrade under bituminous pavements. This will appeal to most engineers as mighty sound practice.

It is quite true, as Mr. Warren frequently mentions, that the modern pavement is an engineering structure; it starts at the subgrade.

Very truly yours,
Hugh W. Skidmore,
Of Chicago Paving Laboratory, Inc., 536 Lake Shore Drive, Chicago, Ill.
Nov. 7, 1924.

FLEXIBLE BASE PAVEMENTS IN THE NORTHWEST

By K. C. Schmidt, Manager of Municipal Engineering Department of Charles L. Pillsbury Co., Minneapolis, Minn.

The results of various tests upon pavements of different types which have been recently conducted, such as the work of the U. S. Bureau of Public Roads at Arlington, Va., the test highway at Pittsburg, Calif., and the Bates Experimental Road in Illinois, have established at least two important facts, to-wit:

First: That the largest single traffic factor tending to disrupt pavements on our modern highways is the stress created by the impact of heavy, high-speed traffic due to inequalities in the surface of the road or foreign matter lying thereon, and

Second: That we must recognize any attempt to design a pavement upon slab principles as fallacious, and look to the subgrade rather than the surface, foundation or base for actual and permanent support.

Temperature Stresses in Northwest

In the northern sections of these United States the disrupting factor next

to impact in the order of its importance is that due to climatic conditions. In a territory where temperatures range from 35 degs. below zero to 100 or 110 degs. above, temperature stresses are extremely vital. Most laymen and in fact many engineers would place temperature stresses as of primary importance, and in the case of residential streets carrying comparatively light traffic, and in certain sections of the country this element may well be conceded first place.

Influence of Impact

It is evident that rigid pavements and foundations do not absorb the continued hammer or impact of trucks and automobiles traveling at high speed to any appreciable degree. Stresses due to impact have been proven by tests to be four or five times (dependent upon speed, and the condition of the road) as great as those due to dead load only, and these enormous stresses are necessarily dissipated largely by recoil to the car or truck or by transmission to the subgrade where in the case of rigid pavements the distribution is exceedingly variable due to lack of uniform contact between the subgrade and foundation. The tests recently made by the Standard Oil Co. of California show that the recoil from a cement concrete pavement due to impact is 1.8 times as great as from an asphaltic concrete slab of like thickness. An automobile ride over the two types of pavement will quickly confirm this conclusion.

A flexible base pavement such as asphaltic concrete or water-bound macadam does absorb such impact stresses to a very large extent and due to its constant contact with the subgrade insures the distribution of that stress transmitted to the grade over a much larger area.

Questions Importance of Slab Strength

While admitting the fact that a slab of Portland cement concrete will warp or bulge away from the subgrade due to the difference of expansion and contraction between the top and bottom portions of the slab, and admitting that such a slab will not adjust itself to slight settlements of the subgrade, advocates of rigid pavements or foundations point to the beam action of the slab and the ability of such a slab to span small depressions and thus maintain a smooth riding surface, as the primary advantage of a rigid structure.

The importance of slab or beam strength in a pavement base has been greatly overestimated. It is in fact a virtue of doubtful merit, for the reason that any bridging of inequalities which develop in the subgrade is only temporary at best. Sooner or later traffic will break through such a bridge. The longer the foundation is sustained as a slab after initial settlement takes place, the larger the area affected is apt to be. This is due to the fact that further displacement of subgrade earth is made possible by the lack of its being definitely confined, and in such case the greater will be the expense of necessary repairs.

Such movement of the subgrade is largely chargeable to the beam action of the pavement foundations and has on numerous occasions been the cause of serious accidents incident to the sudden caving of streets.

Claims a Third Advantage for Flexible Base Pavements.

The third big advantage of flexible base pavements over Portland cement concrete is their ability to withstand the ravages of water and frost, without so much as a crack which will admit water to the sub-grade. Any small surface checks which may develop in the winter are readily closed by traffic during the summer months without maintenance expense.

Concrete on the other hand is vitally affected by each season of its life. Its own coefficient of expansion is large (practically identical to that of steel) and when laid as a pavement this property is exaggerated by its ability to absorb water by capillarity.

The use of reinforcement, expansion joints, and construction joints to control and relieve temperature stresses is a much mooted question among experts on concrete pavements; and their debates at best can only be interpreted as an admission of serious inherent faults in the material with which they strive to work.

Summary of Advantages

The use of asphaltic concrete bases with asphaltic surfaces presents many other advantages besides those mentioned which have on numerous occasions been summarized. Among these are the following points:

(1) East and economy of maintenance, permitting the filling of any low spots which may develop by the ordinary process of "skin patching," requiring a minimum of maintenance equipment, and producing a repair which at once becomes a homogeneous part of the mass at a cost much less than a like repair to any other pavement.

(2) The ready adaptability of local materials to this class of construction.

(3) Base and surface form a homogeneous mass with perfect bond.

(4) Freedom from unsightly cracks common to concrete pavements and rigid bases, which insures a waterproof surface and exclusion of moisture from subgrades.

(5) Long life.

(6) Rapid construction, which means a minimum of nuisance to residents or business men along the street or of detours on country highways.

(7) One construction organization only with reduced equipment.

(8) Longer construction seasons due to the possibility of laying flexible bases in somewhat colder weather and the lack of damage to this type of pavement by night freezing.

Using Old Bases

The term "flexible base" as used in this paper implies either some form of crushed rock base such as Telford and waterbound macadam, or asphaltic concrete, commonly called "black base." Where an old Telford or Macadam foundation or even a first class gravel road exists, such a road can and should be utilized for a pavement foundation. It is almost a certainty that such a road has become thoroughly compacted and has proven its ability to support any traffic it is called upon to carry, and has failed to meet modern demands only in its lack of resistance to the abrasion of rapidly moving rubber tires and in the fact that water readily soaks into and softens the surface. The required resistance to abrasion and at the same time a strictly water-proof surface can be easily and cheaply supplied to such a road by means of a comparatively light surfacing, consisting of a binder course of asphaltic concrete and a wearing course of like material, but of closer grading, or of sheet asphalt. For such work on old Telford or Macadam the total surface need not be more than 3 ins. thick while in the case of gravel a slightly heavier binder or base course will likely be desirable. The resulting pavement will be superior in every respect to a 7 or 8 in. concrete slab and the cost will be much less.

Where an old macadam or gravel roadway does not exist and it is desired to construct a flexible base pavement the use of a black base will in all probability prove more economical and more practical than the construction of a new waterbound macadam base which would have to be much thicker and should generally be given time to age and compact under traffic.

City Work

Because of the closely restricted grade and drainage requirements on city streets, the resurfacing of old macadam in cities, (unless such surfaces are specially heavy, or unless the original macadam surface was left low to permit resurfacing,) is often very difficult and demands the tearing up of the original macadam before the new surface is laid. It is the opinion of the writer that too little thought is paid to this point when laying road surfaces in cities and villages other than high grade permanent pavements.

All surfaces such as Macadams, Telfords, Asphaltic Macadams (penetration process) and Portland cement concrete should be laid 2 to 3 ins. below the ultimate surface grades in order to permit the use of such surfaces as a foundation for asphaltic concrete or other high grade surfacings with a minimum destruction of the old work, and without excessive reduction of the surface.

First Use of Black Base

The use of black base in this country is not new. The first black base pavement laid in the United States was in Washington, D. C., over 40 years ago. Visalia, California, has had such pavement in use since 1894 and there are many examples which have been in use for 20 years or more without material maintenance expense and which have given fully satisfactory service. Many of the prominent installations such as those in Washington, D. C., Washington Street, Chicago (near Marshall Field's), portions of the Columbia River Scenic Highway and the Los Angeles County Harbor Boulevard across Nigger Slough (A Willite process pavement) are widely known and have proven beyond doubt the ability of this type of pavement to withstand traffic of all classes. Instances mentioned above represent ordinary residential sections, crowded retail districts, high speed tourist travel and the trucking of wholesale shipping.

Black Base Little Known in Northwest.

In the so-called Northwest, however, black base is but little known. There are, to the writer's knowledge, but two pieces in the States of Iowa, Wisconsin, Minnesota, North and South Dakota; one of these is located at Clinton, Iowa, and the other has just been completed under the

supervision of the writer in an exclusive residential sub-division of Minneapolis, known as the Country Club District.

Flexible bases such as a macadam, are, however, not uncommon in this section and have established themselves as highly favored pavements wherever used. There are excellent examples of asphaltic pavements on macadam in Dubuque, Iowa; Rockford, Illinois; Little Falls, Duluth and Virginia, Minnesota.

Where the Sub Grade is Questionable

It is worthy of mention that flexible bases are very commonly selected for use in cases where the quality of the subgrade is in question, and engineers do not dare to risk a rigid base, and that in such cases the flexible base adequately meets the demands made upon it. The Los Angeles road across "Nigger Slough," already cited, is an example of such an instance; another is the so-called Wayzata cut-off between Minneapolis and Lake Minnetoka. This latter road consists of a Warrenite Bitulithic surface and binder course on a crushed rock base and was built on a comparatively new grade across a lake swamp. After construction in 1921 the grade upon which this surface was placed settled to a very great extent; the settlement approximating 12 in. on portions of the road. The surface and rock base have followed the sub-grade down without any sign of cracking or impairment of the riding qualities of the road. It requires little imagination to visualize the almost certain failure of a rigid concrete road under similar conditions.

Natural Cement Bases

Another type of flexible base very common in the Northwest and in fact in all larger cities, though not commonly thought of as such, is the old natural cement concrete base which was very extensively used before the era of Portland cement.

The writer has on many occasions observed resurfacing operations or cuts for water and sewer service through such bases. In every case the natural cement had lost all cementing properties and the concrete was readily shoveled from the cuts; and yet these bases have sustained excellent surfaces where well sealed, for periods of 20 to 30 years and are still good, although they lack even the qualities of a keystone bond possessed by a good macadam.

Minnesota's First Black Base

The black base pavement in the Country Club District at Minneapolis, which was referred to above, is Minnesota's first work of this kind.

It was adopted by Thorpe Bros. the Realtors responsible for the sub-division, after a very thorough study, and in competition with numerous other pavements. The pavement as built consists of a 1½-in. Warrenite Bitulithic surface on an asphaltic concrete base. The total contract comprised approximately 42,000 sq. yds. about one-half of which was laid with a 4-in. base and the remainder on a 3-in. base making the total thickness 4½ and 5½-ins.

The subsoil conditions presented a variety of material ranging from heavy clay to coarse sand and gravel. The clay sub-grade was lightly ballasted with sand or gravel to destroy the capillarity, while the sand and gravel sub-grade insured excellent drainage. All sub-grade was thoroughly compacted by means of a three wheel roller, although some difficulty was encountered in rolling the sand alone, and it was necessary to resort to hand tamping or planking before the first rolling. On the sand sub-grade where moisture did not hinder the work, water was used liberally to assist in compacting the grade before rolling.

The base mix consisted of gravel excavated from a knoll at one edge of the sub-division which was graded from 2½-ins. down. This mix carried 72 per cent of rock retained on a 10 mesh screen and 28 per cent of fine material, approximately 4.5 per cent of asphalt of 55 average peneration was used in the base course. The fines used for the base mix were the same as for surface course except that no dust was added. Base mixture was generally run for two days and surface mix to cover it was run on the third day. Due to the rapid development taking place in the sub-division little attempt was made to keep traffic off the base. On much of the work mixture was hauled over the base as laid, and many observers remarked upon the supporting power of the base mix while still warm and after the initial rolling only. The loaded trucks weighed approximately 17,000 lbs. but made no impression where they passed.

When it was deemed advisable to keep traffic off the base course because of dirt, the streets were generally opened on the third day after closing, or immediately upon completion of the surface course. This time considered in contrast to two or three weeks required for the curing of a concrete base or three to four weeks for a concrete pavement is an outstand-

ing advantage in black base construction, particularly in business districts.

The surface course was composed of a mixture of natural and crushed gravel from the same source as the base mix. There was nothing new or of special interest in the construction of this course except possibly the details of the mineral grading specification.

Mineral Grading Specifications

I quote below a grading specification in common use for coarse graded asphaltic concrete mixtures.

"The total Mineral aggregate shall be so graded that the resulting mixture shall conform to the following limitations.

Passing 1¼" screen and retained on ¾"	15	35%
Passing ¾" screen and retained on ¼"	15	35%
Passing ¼" screen and retained on 40 mesh sieve	12	28%
Passing 40 mesh sieve and retained on 200 mesh	9	25%
Pass 200 mesh seive	6	8%

It has been the experience of the writer that such a specification is very unsatisfactory, for the reason that the permissible range for large sizes of rock is too great or not sufficiently definite, that the ideal is seldom the mean of the specified extremes, and that the specifications must frequently be interpreted by inspectors capable only of arbitrary rulings. It is possible by swinging to permissible extremes for various sizes of rock to secure an exceedingly unsatisfactory mixture which would still be within this specification.

In an attempt to make a more definite specification and one which could be interpreted and visualized by ordinary inspectors the writer devised the following clause which has been used for the past year with a great deal of satisfaction:

"The total mineral aggregate shall consist of a uniform mixture of the broken stone, sand, and mineral filler, the required grading of each being such as to produce, when properly proportioned, a mixture conforming as nearly as possible to the following grading which for purposes of this pavement is established as an ideal.

Passing 1¼" and retained on 1"	14.3
Passing 1" and retained on ¾"	14.3
Passing ¾" and retained on ½"	14.4
Passing ½" and retained on ¼"	14.4
Passing ¼ mesh and retained on 10 mesh sieve	11.5
Passing 10 mesh and retained on 40 mesh sieve	5.6
Passing 40 mesh and retained on 80 mesh sieve	12.0
Passing 80 mesh and retained on 200 mesh sieve	9.0
Passing 200 mesh sieve	4.5
Total	100

Maximum variations from the above grading will be permitted as follows:

Passing 200 mesh		1½%
Passing 80 mesh and retained on	200	2 %
Passing 40 mesh and retained on	80	3 %
Passing 10 mesh and retained on	40	3 %
Passing ¼ mesh and retained on	10	3½%
Passing ½ mesh and retained on	¼	3½%
Passing ¾ mesh and retained on	½	4 %
Passing 1"		4 %
Passing 1¼"		5 %

Provided, however, that the algebraic sum of the variations from the ideal of two successive sizes shall not exceed 6 per cent of three successive sizes, 3 per cent. The above grading standards may be modified from time to time by the engineers to conform to the requirements of the materials used."

The ideal mixture given follows Fuller's grading Curves for coarse material, (in excess of 1-10 of maximum diameter) with a sheet asphalt mortar of standard heavy traffic mix. The mixture is plotted and fully explained by Roy M. Green, Associate Professor of Highway Engineering in Bulletin No. 22, Texas Engineering Experiment Station.

The daily report form used by the writer requires the inspector to compute the mixture from his daily sieve tests and box weights and plot same against the ideal curve, which for convenience is plotted as a straight line, as suggested by Professor Green. The inspector then sees a picture of his mix and by reference to his screen tests of the separate bins can rapidly correct any variations in the grading.

It was first thought that the permissible variations set by the above specification might be too close but after a little use we find no great difficulty in keeping the mixture within the specification limits.

The asphalt used for the surface mix was slightly softer than that employed in the base averaging 65 penetration.

The Country Club District pavement is of interest not only because it is Minnesota's first black base but because the mineral aggregate was taken immediately from the property to be improved, and because of the nature of the district in which it is laid. This district will undoubtedly, because of the conveniences afforded the Country Club and golfing advantages and the building restrictions, be one of Minneapolis' finest residence sections. Incidentally the black base is receiving a great deal of publicity. Each lot salesman has been provided with a small sawed section of the pavement and extols the virtues of same as a part of

his sales campaign to prospective lot purchasers.

Progressive Development

In closing I wish to emphasize the often urged need of greater attention to progressive development in the building of our new highways. In a letter to Engineering News Record published March 6th, 1924, Mr. Troy Carmichael, City Engineer of Helena, Montana, says "The highways in the United States where traffic demands a dirt road today, and a paved highway tomorrow can be counted on both hands. Yet how many miles of hard surfaced roads have been built over subgrades from a month to a year old?"

The above quotation tells a complete story of modern highway building in many sections of the country. The rapid growth of automobile traffic in recent years is so unprecedented, and prior to the last decade the bulk of our national roads were so poor that the extremes so frequently adopted are not unnatural. How much better it would be if we would build our road grades today with perhaps a surfacing of sand and clay or a light course of gravel and perfect the drainage, then place heavier gravel or macadam a few years hence on a thoroughly seasoned and settled sub-grade and when traffic demands a higher type of surface because of excessive maintenance costs, have ready for use a tested and proven foundation to carry the load. A comparatively light asphaltic surface 3 or 4 ins. thick, costing approximately one-half the price of a standard concrete slab would then complete a very superior highway which with few repairs and small maintenance costs would provide a really permanent structure.

In many cases such development will leave logical room for penetration macadams or processed roads such as the so-called "Rawhide Pavement" between the initial gravel or sand clay surfacing and the final treatment. In such a case the investment for this treatment would not be lost as it would become a valuable base and further lighten the necessary surface course.

My observation and belief is that properly constructed flexible base pavements will meet all demands of modern city traffic more satisfactorily than pavements of rigid character and generally at lower first cost, and I am willing to venture the prophecy that combined with a program of progressive development of highways, flexible base pavements will furnish the ultimate answer for our highway surfacing problems as well as our city pavements.

The foregoing paper by Mr. Pillsbury was presented before the Third Annual Asphalt Paving Conference at Louisville, Ky., Oct. 14, 1924.

WATER-WORKS IMPROVEMENTS AT WINNER, SOUTH DAKOTA

By George T. Prince, of Prince-Nixon Engineering Co., 628 Omaha Grain Exchange Bldg., Omaha, Nebr.

The City of Winner, South Dakota, is located in a district in which it is difficult to obtain water in large amounts sufficient for public water supplies.

Such water as is obtainable is to be found underground. The sub-soil generally is of a very fine sandy nature that makes it difficult to obtain the water because of the packing and encrusting nature of the fine sand sub-soil about the strainers employed in connection with the tubular wells.

Former Supply

The City has in the past been depending upon water for its public needs that is obtained principally from two 24-in. Kelly wells sunk to a depth of about 28 ft. and reinforced by about 15 wells of 6-in. tubular type that were sunk approximately 28 ft. All of these wells were connected to an 8-in. water main that was laid at a depth of approximately 8 ft. below the surface of the ground.

This well system is located about 8½ miles south of the City of Winner on ground about 80 ft. above the elevation of two circular concrete reservoirs that are located about one mile south of the center of the town, and that afford a static pressure in the business section of the City of about 60 lbs. per sq. in. The connecting pipe between the reservoirs and the aforesaid well system is an 8-in. machine banded wooden pipe.

There are no authentic records indicating the amount of water used in the City of Winner which has a population of approximately 2500; the nearest estimate would indicate from 100,000 to 125,000 gals. per 24 hours, and this amount of water has had to be pumped in recent years from the two 24-in. Kelly wells. The 15 smaller tubular wells having Cook strainers have not afforded any water as the sand bed from which the water is obtained is very fine, the coarsest being about like granulated sugar and this sand

has become encased around the screens to such an extent that the tubular wells have practically been useless for some years.

Water Shortage

Because of a shortage of water the city authorities employed a number of engineers to submit reports upon ways and means that might be employed to enlarge the amount of water for public purposes, and the speaker submitted tentative plans for obtaining the desired additional water supply, which were finally adopted and approved by the Council of the City of Winner and a contract was effected between the City and an Omaha contracting firm based upon detail plans and specifications formulated by the writer, which embodied the following plan of procedure:

Collecting Gallery

It was believed that the fineness of the sand sub-soil precluded the use of open jointed and perforated underground pipe lines and in place of employing such a type of construction, it was decided to adopt that of an open trench which was to be excavated across the draw in which the aforesaid wells were located. This draw is about 500 ft. in width and experience indicates that a large portion of the drainage from 20 square miles located above and to the south of the said system of wells passes as under-flow below the draw in which the wells are located and about 15 to 25 ft. below the ground level.

The adopted plans considered excavating a trench across the draw having a width of 6 ft. inside and a depth of about 15 ft. below ground level; the said trench to be sheathed with 4-in. thickness of sheathing plank that was made up by nailing together two 2-in. planks, the planks being so lapped as to leave at least 6 ins. The two planks being thus nailed together for their entire length with their 6-in. lap formed a couple, and contiguous couples on either side made it possible to make tight work, each couple lapping the companion by 6 ins. These planks nailed together in couples were first sunk by water jet to the required depth. The sheathing forming the upper or south line of trench was sunk to a depth of 18 ft. below ground level or 3 ft. below the bottom of the trench when excavated and those forming the lower or north side of the trench were sunk approximately 22 ft. below ground level or about 7 ft. below the bottom of the trench as excavated, thus forming a submerged timber cut-off against the passage of water.

The Trench

The trench was afterwards excavated as stated to a depth of about 15 ft. below ground level, the sides of the trench being firmly braced by longitudinal and transverse members as the excavation proceeded, said bracing being spaced from 3 to 4 ft. apart vertically.

The purpose of making this trench 6 ft. in width was primarily to make it possible to sink Kelly wells to a depth below the bottom of the trench should it develop that such a measure would be necessary to secure the desired amount of water.

The sheathing plank at the east end of the trench for a distance of 10 ft. were sunk to a depth of 24 ft. below ground level. The reason for sinking the plank sheathing deeper at the east end was to provide a sand pocket into which sand that might be held in suspension in the water would be deposited before entering the outlet pipe, which is connected with said sand pocket at an elevation approximately 15 ft. below ground level.

The tops of all sheathing plank were sunk to a depth of 2 ft. below ground level and furnish a support upon which was placed a 6-in. steel reinforced concrete cover that extends for the full length and width of the collecting gallery. The gallery is 300 ft. long.

Operating Details

Five manholes have been constructed of concrete which extend above the concrete cover to ground level upon which iron frames and covers have been placed to afford means of entering the gallery should occasion require for inspection and possible removal of sand.

Over the concrete slab there has been placed earth filling to an elevation slightly above ground level to allow for settling, this earth filling has a 6-in. topping of black soil and will be seeded so that the gallery will be covered by grass sod and present a smooth surface with the surrounding field.

The water level in the gallery when no water is being drawn stands approximately 4 ft. below ground level, and it is believed that the sheathing plank will last indefinitely under these damp conditions. If, however, in years to come it is necessary to replace the tops of said plank sheathing, this can be done at small expense.

The water level with the gallery in

service is drawn down about 4 to 5 ft., and it is believed that this collecting gallery will afford an ample supply for the needs of the City for some years in the future. At present the City is not using the amount that the gallery will afford, which at present is approximately 300 gals. per minute.

In order to deliver the water from the gallery at a depth of 15 ft. below ground level it was necessary to lay 2,500 ft. of 10-in. cast iron pipe connecting with the existing 8-in. machine banded wood pipe, whereby it is possible now for the City to dispense entirely with pumping its water supply, the water being delivered by gravity into two concrete circular reservoirs, each having a capacity of approximately 80,000 gals.

Such in brief is a description of the methods adopted to obtain the required additional water supply. The cost for the 330 ft. of collecting gallery complete was $11,500.

The foregoing paper by Mr. Prince was presented at the 1924 meeting of the Iowa Section of the American Water Works Association.

WORK OF THE ENGINEER IN PREVENTION OF MALARIA AND MOSQUITO NUISANCES

By J. A. LePrince, Chairman, Committee on Engineering, National Malaria Committee, Room 17, Court House, Memphis, Tenn.

Prominent engineering journals recently commented on the memoirs of Ronald Ross, the pioneer in malaria elmination, but omitted mentioning the fact that much of the future success to be achieved along this line as well as the methods to be followed must be devised or created by engineers.

Ross did not stress the point, although it is true, that due to engineering practice as now carried on, the engineer is frequently responsible for the creation of mosquito pest nuisances as well as the spread of malaria, or as an American malaria field worker stated, "How long will it be before our engineers stop building marlaria in, instead of building it out?"

Man-Made Malaria

Much man-made malaria or "engineer-made Anopheles production" is going on in other countries as well as in our own, and the time appears to be appropriate for our engineering societies to inquire why this is so and to determine what should be done about it. Some of our engineers at Panama, during the canal construction period, considered the anti-yellow fever and anti-malaria measures as more or less of a joke and referred to the field workers as "mosquito chasers."

An Engineer Who Blundered

Eight years later the chief engineer of one of our largest American corporations working in a foreign country was selected and appointed to direct measures against yellow fever that threatened his and other American business interests. He promptly ordered one thousand tents, employed several hundred men to do work that had no relation to the problem involved, and wasted many thousand dollars but did not accomplish one cent's worth of results toward yellow fever control or elimination.

During the recent epidemic of dengue fever that swept through our southern states from the Atlantic Ocean to Texas, no reference was made by our public press, engineering publications, or engineering societies, to the fact that our street storm water catch basins, present by hundreds in many cities and towns, are sources of millions of the mosquitoes involved in mosquito-borne disease. Yet without question a well selected committee of our American sanitary engineering associations could devise an economical modification for these catch basins in use, so they would become self draining and no longer a potential or actual menace to the health of the communities where now in use.

A Plea to Engineers

An earnest effort was made recently by the Committee on Engineering of the National Malaria Committee to correct these and other defects and so to arrange that engineering students of our technical schools could learn in a short time, by a single lecture if necessary, not to permit engineering construction operations to become a source of serious epidemic disease outbreaks.

Unquestionably more far reaching results could be obtained if some of our prominent engineering associations could be interested in this matter and determine what is being taught in our technical schools relative to that part of applied public health that will be of actual use to our future engineers and to determine what portion of such schools show the students where they can get the information and facts rapidly later, if they ever have occasion to need them.

Engineering and Public Health

Also these same associations through their professional journals could at least invite attention to the need of practicing and consulting engineers considering the public health problems involved or connected with many engineering operations, such as irrigation, major drainage projects for agricultural drainage, impounding of water, extension of town suburbs, construction of highways and railroads, sewer outlets, borrow pit construction, etc.

Apparently the essentials of this subject, or the relation of engineering construction to public health problems, should in a brief way be presented to all students in our army engineering school so that any small but very necessary item of expenditure necessary for malaria control in connection with Government impounded water projects, or other large engineering projects, could and would be made and included in the appropriation or budget before the project is started. It would be too late to try to apply a remedy after the country surrounding the project is rendered unfit to live in.

What the Engineer Can Do

In order to make this paper brief and to the point, a partial list of what the engineer can do is given below and it is hoped that engineers will determine what should be done and then start devising means for accomplishment.

(a) Devise a means of presenting this subject before the national and state engineering associations.

(b) Obtain the cooperation of these associations so that a practical plan can be adopted to prevent the constantly changing county highway commissioners and county highway engineers allowing borrow pits and roadside ditches to be so constructed that they become intermittent or permanent sources of malaria-bearing mosquitoes and sources of potential foci of malaria.

(c) In this connection in each state both for the benefit of the roads as well as the proper drainage thereof there should be a State Association of County Highway Commissioners and the County and State Highway Engineers should attend the annual meeting of that association.

(d) A strong effort should be made to interest the general managers and chief engineers of the railroads in the malaria belt of the United States, in the financial losses now caused to railroads by malaria, including:

Inefficient labor employed.
Increased labor turnover.
Retarded development of territory served.
Decreased output of mills and manufacturing agencies.
Reduction of freight hauled.

(e) The State engineering associations should be invited to investigate the anti-malaria operations as being carried out by the state board of health of their state, and act as a body in endorsing or giving constructive criticism on what is now being done toward malaria elimination, rate of control progress, etc.

(f) Interest consulting and municipal engineers in the mosquito problem and let sufficient of them understand that a relatively mosquito free community will suffer from heavy mosquito infestation as soon as water of natural drainage courses becomes polluted with sewage water. That the production of pestiferous mosquitoes in clear water as against strong sewage polluted water may be as 1 to 1000.

(g) The engineering profession must let the local government officials and the public know that sluggish water courses in town suburbs are a public nuisance, often the main source of our town mosquito pest problem, and frequently a menace to health. In the malaria belt of our country the normal (non-storm water) flow should travel through a properly devised concrete lined section in the bottom of the water course or by pipe line to a point beyond mosquito flight range.

(h) Our underground culverts used in place of large pipe and carrying a small normal flow of water should not have flat bottoms. A depressed rounded central channel along the center line of the floor and gently sloping sides will prevent mosquito production. Long culverts with flat grades to convey storm water under town suburbs are yet being built and are sources of our mosquito pest. They are frequently so designed or constructed that it is not practicable to prevent mosquito production in them.

(i) In view of the fact that state development will rapidly follow the proper development of hydro-electric power, impounded water projects constructed by our federal government should be so planned as to produce a practical minimum of malaria, and the methods of malaria control used thereon should be a

standard for private enterprises to follow. In the past this phase of the public health problem has not been given consideration.

(j) Most of our practicing engineers, engineering construction corporations and contractors, have not been taught what serious malaria problems are and do not recognize them at sight. The engineer can build malaria into a community for all time to come or build it out of a community. Which is he going to do and why?

(k) Such small items as the location of municipal swimming pool, recreation park, or auto tourist camp, etc., where no consideration is given to the Anopheles problem near it, can seriously affect the annual malaria sick rate of the near-by town.

(l) Sir Ronald Ross states that it takes ten years for a nation to get a new idea. It was twelve years after the first successful anti-malaria campaign carried on by Americans in Cuba before we started any worth while similar work in our own country.

Nevertheless, the writer does not accept the idea that it will be another ten years before the engineering profession of our country appreciates the commercial and financial value of malaria elimination.

Possibly greater progress has been made in our country than in any other in devising more economic and more rapid control measures, but the rate of progress can be increased tenfold if our American engineers become seriously interested in this subject which affects the normal development of thirteen States and the comfort of the public in many others.

The foregoing paper by Mr. Le Prince was presented before the recent annual meeting of the American Public Health Association.

GREATER SAFETY AT RAILROAD HIGHWAY CROSSINGS

By Charles E. Hill, General Safety Agent, New York Central Lines, 466 Lexington Ave., New York, N. Y.

In discussing safety regulations at railroad highway crossings we must do so from a broad standpoint having in mind not only the problems with which we are confronted today, but take into consideration the conditions we may reasonably expect to exist in the future. This subject is a vital one and is of tremendous importance, in any plan we may adopt in our efforts to reduce accidents at railroad highway crossings.

In taking up the railroad highway crossing situation we must approach it from a national viewpoint for it has indeed become a national problem, one which has perhaps created more discussion than any other question in which the railroads of this country and the public are mutually concerned. While the crossing accident problem is but one of the many types of problems with which the railroads have to contend it is of no less importance and today is being given greater consideration by the railroads than ever before.

Before entering into a specific discussion of this subject, let us broaden out, so to speak, and take a retrospective view as it applies to the entire accident field. One of the outstanding problems of the country today is the frequency of accidents—it matters not from which angle you may view it. The enormous life wastage, due to accidents as a result of the lack of carefulness on the part of our citizens, is appalling.

Only recently was my attention directed to a newspaper article concerning an accident to a man in Wisconsin who placed four sticks of dynamite under a stump, lit the fuse and calmly sat down on the stump. The next day at the hospital it was reported both arms were broken, several ribs fractured and his eyes so badly burned his sight would be destroyed. This is not an unusual accident for we are having like occurrences every day all about us as is evidenced by the fact that last year in the United States there was a daily average of 250 deaths and 6,000 injuries due to accidents from all causes, whereas during the 19 months we participated in the World War, with two million of our men in the service, the toll casualties per day was 100 killed and 220 wounded—the casualty record being only 1/20 as great as that occasioned by accident to our citizens while engaging in peaceful occupation, and yet America is not aroused to a full realization of the situation. The difficulty lies largely in the apathy of our citizens who have not as yet had their conscience awakened to these everyday tragedies. The reason the public mind has not been aroused to the seriousness of the accident situation is due to not being fully appreciative of this enormous life wastage resulting from carelessness and *thoughtlessness*. This appalling loss of life does not occur in one

accident or at one place, but many accidents and numerous places are involved, and for this reason the publicity which seems necessary to bring effective results is not given.

The call for co-operation of the American Public to the end that human life and limb will be conserved for the uses for which they were intended should meet a hearty response for the results obtained affect society as a whole. Since all good citizens are concerned in the conservatism of human life and limb, I feel that it is important that I emphasize the spirit of co-operation that should obtain between the railroads of the country and the American public to the end that greater progress will be made in this humanitarian effort.

To What Extent Are Crossing Accidents Contributing to Our Casualty Record?

In considering that phase of our accident problem relating to railroad highway crossings we find that during the 7-year period from 1917 to 1923, inclusive, there was an average of 1,882 deaths and 5,100 injuries per year, and during 1924, it is estimated, there will be 2,800 people killed and 8,000 injured in accidents of this character, or an average of 30 casualties per day as compared with 9 per day 12 years ago, an increase of 233 1/3 percent. These figures not being in harmony with our increase in population during the same period, which is only 15 per cent.

We must not overlook the fact that casualties resulting from accidents of this character are not confined to the users of the highway, for in 1922 there was 68 of these accidents that not only caused death and injury to the traveler on the highway, but also to 138 railroad employees and passengers. Not only that but 27 of these collisions at highway crossings caused derailments to the trains, inflicting a heavy casualty toll and a substantial property loss, as well.

The Physical Situation

We have in the United States 256,362 crossings at grade. In seeking a remedy we must do so not only with the knowledge of present day conditions, but also upon the theory that the immediate future holds no panacea in so far as the physical situation is concerned, for it has already become an acknowledged fact that a solution through crossing elimination is unthinkable, by reason of the prohibitive expense, which is conservatively estimated at 20 billion dollars, and the time required to perform such a stupendous task.

A gradual process of elimination has been, and still is quite properly being carried on by the railroads, but this process has been seriously handicapped by the addition of many more new crossings during the same period of time. For example, in 1922 there were 706 crossings eliminated at a cost of 70 million dollars, but during the same year 4,560 new crossings were added. Even should the process of elimination be on a more general scale, even then, we could not hope for a full realization of this remedy for many generations to come. We must, therefore, accept the situation as it exists and try to find a remedy that will meet present day conditions.

The Motor Vehicle

We have in the United States 15,300,000 licensed automobiles. The motor vehicle is specifically involved since it will be concerned in 90 per cent of our crossing accidents this year. Not only that, but we must take into consideration that the number of motor vehicles will continue to increase, for it has been estimated that in ten years from now we will not only have one car for every seven persons as exist today, but this ratio will be increased to one car for every four persons. In fact, by 1933 it is estimated there will be 33 million automobiles in this country, which will be a sufficient supply for practically every person that is old enough to reach the steering wheel.

This statement is not a condemnation of the motor car, but merely emphasizes the sagacity of the American people. If we were like Siberia, with only three motor cars, or like China, with only 8,150 automobiles to occupy the attention of her 150 million inhabitants, we would not have such a task confronting us, but who wants to live in Siberia or China? I thank God that I am living in progressive America where we have problems to solve and where we never stop until we solve them. The automobile, today, is an absolute necessity in the conduct of the business of this country, and progress will demand not only its continued use but a greater extension of its services. It is by reason of this situation that it becomes imperative that we, in our attempt to provide a remedy, not only endeavor to take care of our present day needs but of the future, as well, and this will include a regulation of the use of the motor vehicle so that it will serve the purposes for which it was intended.

I have drawn your attention to the physical situation, both as it applies to railroad highway crossings and motor vehicles which are the factors standing prominently to the foreground in connection with this subject and form the basis upon which we may proceed.

Analysis of Accidents

Analysis of accidents precedes intelligent remedy. In order that we may undertake to bring about a reduction of accidents we must know their causes. We have applied this rule with success in the reduction of our employee casualties. Therefore, it is necessary that we not only know how many deaths and injuries occur as a result of crossing accidents, but we must know where they occur, when they occur and how they occur, otherwise, we will be at sea as regards the application of an intelligent remedy.

In analyzing accidents of this character, we find that 70 percent occur in daylight and 63 percent at crossings where the view is entirely unobscured, and, contrary to general belief, not only do most of these accidents occur in daylight and where the view is open but at crossings with which the drivers are entirely familiar. This would lead to the belief that the drivers being so familiar with the conditions lull themselves into believing they are immune to danger and either drive on the crossing with no thought in so far as their personal safety is concerned, or they see the train approaching and attempt to put on more speed to beat it over the crossing. It is further enlightening to know that one out of every seven crossing accidents is due to the driver running into the side of moving trains. There might be some excuse for colliding with the forward portion of a train, but when the collision occurs 40 or 60 cars from the forward end, it would seem this would resolve itself into an extremely reckless act.

We find that a large number of drivers are incompetent due either to mental or physical deficiency. Mental, due to inability to understand or read the English language, thereby, not having any positive instructions regarding the operation of the cars, and physical, by reason of defective sight and hearing, immature age or enfeebled condition, due to old age. It is not an infrequent occurrence for drivers included in the first class to have no knowledge of any legal requirements, and as a result they drive rapidly by advance warning signs, which silently command them to reduce their speed, and in many instances the latter are considerably over 70 years of age—not infrequently more than 80 years old, and sometimes as young as 10 years of age, incapable of not only handling the car properly, but of appreciating the danger inherent in its operation.

A large number of accidents of this character can also be charged to intoxication. It is certainly indicative of something lacking in our laws when men of the type described as mentally and physically defective are permitted to operate automobiles, but it is obviously grossly neglectful to permit them to operate cars while in an intoxicated condition. One of the judges in New York City recently remarked from the bench that an automobile in the hands of an intoxicated driver was more dangerous than a loaded revolver in the hands of a maniac on a crowded street.

Contrast the comparative qualifications of the driver of the automobile and the driver of the locomotive. The former, as a rule, needs no qualifications other than his ability to possess a car. He is not only unfamiliar with its operation but is lacking in a knowledge of our laws which have to do with the regulation of its use on the highway. Furthermore, in the majority of instances his responsibilities are such that he is weakened in his regard for the rights of others. Whereas, the locomotive engineer has earned his right to a seat in the cab of his engine by virtue of many years of training. He is entirely familiar with all of the rules of operation as well as the mechanism of his engine. His responsibilities are a part of his make-up. He sits in the cab not only with these qualifications but with a steady hand, a clear head, a brain that is in no wise affected by anything he may have drank and with a keenness which is so alert that he, in fact, is a very part of the locomotive being operated under his guidance.

In continuing our analysis it was found that about 25 per cent of the drivers did not use the care requisite to safety in approaching crossings and about 5 per cent were extremely reckless using no care whatsoever, having no thought of their personal safety or the safety for others.

Thus, we find the majority of drivers are reasonably careful, just as we find the majority of the American people are honest, for if the latter were not true, anarchy indeed would prevail, and if the

majority of our motorists did not use caution our country would be depopulated in a few years; but while the percentage of dishonest citizens is small it is sufficient to clog the courts, fill the jails and penitentiaries, and while the percentage of careless drivers is small it represents a large army of more than three-quarters of a million of reckless demons sufficient thereof to fill the hospitals and morgues.

The reckless motorist is regarded as the greatest menace we have today in the safe operation of passenger trains for, indeed, he is a potential train wrecker. I have already called your attention to the fact that his acts in one year alone caused 27 derailments entailing serious loss of life and property.

The people want to feel that when riding upon the trains of this country they will reach their destination safely so that upon this hypothesis alone the public should be vitally concerned in this momentous question.

As a striking contrast of the increasing toll of lives resulting from crossing accidents, it is interesting to note that the number of passenger fatalities on the railroads of the United States during the past 10 years has decreased 34½ per cent; in 1922 there being only 200 deaths, notwithstanding the fact that there were carried that year 969 million passengers, or nine times the population of the United States, which was equivalent to the hauling of 35½ billion passengers one mile. This feat alone, is justification for the statement that passenger travel is relatively safe. Can we say as much for travel by automobile when during the same period the number of deaths from all causes increased 600 per cent. While the railroads have in certain instances reduced the speed of some of their best passenger trains as a greater assurance of safety the speed of the automobile has increased, the act of foolhardiness being changed from "Blowing out the Gas" to "Stepping on the Gas."

Joint Responsibility

We must proceed upon the theory that there is a joint responsibility between the railroads and the public at large. The railroads have a duty to perform and the special activities conducted by the railroads of the United States through the Safety Section of the American Railway Association in 1922 and 1923 is indicative of the interest the carriers are assuming in this important problem. The fact that these special efforts are to be conducted by the railroads during the year 1924 at an enormous expense surely evidences the fact that the railroads are fully appreciative of their responsibility in the matter. In carrying out their part of the program they have proceeded and are continuing to proceed upon the theory that they have a responsibility and that they must perform their duty in order to be able to go to the public with clean hands.

The duty of the railroads lies largely in train operation, crossing maintenance and crossing protection. Special efforts have been put forth to perform these duties in such manner as will minimize the hazard of crossing accidents in so far as this may be accomplished by the railroads alone. Crossing protection has given the railroads serious concern for we have never as yet been able to devise any character of protection that could be considered fool-proof, or that will have any deterrent effect on the careless driver, for it is a daily occurrence for reckless drivers to disregard audible or visual signals, run down crossing flagmen and crash through crossing gates in the path of approaching trains with disastrous results, and when the latter is true, the driver is usually confronted by Saint Peter with the admonition, "It were far better that you let the crossing gates close in front of you than the pearly gates behind you," and it is to be regretted that this warning could not be emblazoned from the firmaments of heaven in the face of those who either know not or care not what they do.

We now reach the proposition as to the part the public at large can assist in this humanitarian work. I have heretofore stated that this is a joint responsibility and that there must be cooperation between the railroads and the public in order that there may be any degree of success. In fact cooperation is the essence of success and no institution can hope to succeed unless this is made one of its basic fundamentals. Cooperation has been a potent factor in the success of organized effort making itself felt in the field of accident prevention, particularly as it has been applied to the casualty record of railroad employes. It is by reason of this splendid cooperation that casualties to railroad employes during the past 12 years have been reduced 54 per cent—this being accomplished in face of the large increase in the number of persons employed.

The Remedy

The remedy is to adopt some means

that will curb the reckless motorist. This plan can only be accomplished through a unity of effort on the part of not only the railroads but the public as well. As an aid to this plan I would suggest the public can render effective service by carrying out the following suggestions:

1. The prevention of unnecessary building of highways across railroad tracks.

2. The elimination of grade crossings by the rerouting of highways wherever possible.

3. The execution of laws relative to the erection and maintenance of advance warning signs where such laws exist.

4. The elimination of obstructions to view, such as the prevention of the erection of signboards and other unnecessary obstructions within 500 feet of the crossing.

5. That the several states enact stringent laws requiring a proper standard of qualifications making it impossible for motor cars to be operated by those who are unable to meet the required mental and physical tests. Laws of this kind will aid but not cure the evil for this does not entirely weed out the chance taker or the careless and thoughtless, who are to be found in all walks of life.

Motor Vehicles and School Buses Operated for Hire

Sixteen states have quite properly and wisely, through the various public service commissions, promulgated rules requiring motor vehicles operated as common carriers to stop before driving over railroad crossings. Some of these states have not applied this rule to motor vehicles carrying freight. It is not an uncommon thing for a heavy truck, likewise carrying heavy tonnage, to collide with a train—the results, of course, being disastrous. Certainly they should be required to stop before attempting to pass over any railroad crossing. In a number of states this rule also applies to school buses, with a severe penalty for non-compliance. One of the means by which the cooperation of the public will avail in this humanitarian work would be for this rule to be applied to the three classes of vehicles named not only in the 16 states referred to, but this rule should likewise be extended in the remaining 32 states. As a result of this cooperation material aid will be rendered in the reduction of accidents in which this class of vehicles is involved. This would be, indeed, a forward step in the line of progress that will reflect favorably in our joint efforts to reduce these accidents.

Some of our states have laws requiring the driver to slow down, either to a definite speed, usually 10 miles per hour, or to a reasonable speed upon passing the advance warning sign 300 ft. from the crossing and not to increase this speed until after the crossing has been passed. This is a good law and a reasonable requirement and if adhered to literally crossing accidents would be greatly diminished. Unfortunately the law is not respected, and I think the chief difficulty is largely due to the fact that the judgment as to the care exercised is left to the driver. Laws of this character are not effective by reason of this particular defect. A requirement of a positive nature would not leave any room for argument and, in my judgment, merits the earnest consideration of all concerned.

Six states have positive stop laws in varied forms, and I am advised that they have proved effective in a reduction of accidents of this character. Education is one of the means by which we may hope to bring about an improvement and I have great faith in the results accruing through a process of education; however, as an adjunct to this I feel that accidents at railroad highway crossings will not be appreciably reduced until the reckless driver, to which I have referred, is restricted by law (with suitable penalty for violation) as to the manner in which he approaches and passes over such crossings. This requirement must be of such a positive nature that he will understand its meaning.

The teaching of safety reaches back many thousands of years and in fact many pertinent statements well worthy of our serious consideration are to be found in the Bible, your attention being invited to Proverbs 27-12 wherein Solomon says, "A prudent man foreseeth the evil and hideth himself, but the simple pass on and are punished." Solomon was a great exponent of safety and I think he must have been looking ahead thousands of years and that he visualized the reckless motorists, and since he was the wisest of kings, I feel that his utterances should receive our respectful consideration for in paraphrasing his statement it reads: "A careful driver sees the danger and stops, but the reckless drives on and is killed."

We have many laws on our statute books that are primarily for the purpose of curbing crime that apply wtih equal

force to those who need no law. The vast majority of our citizens need no rule of conduct, but to thwart crime it is essential that laws are invoked that in some instances may seem to infringe upon our personal liberty, and I believe the time will come, and not in the far distant future, when in order to curb the recklessness that seems to have made itself particularly felt in the motor driver it will be necessary to have laws restricting the careless drivers as to the manner in which they approach and pass over railroad highway crossings and that these restrictions will be of such character that even the reckless will take heed. We must remember that we are in a country of progress and we must keep pace with the situation that confronts us.

One of the most forward steps that has been made looking toward constructive efforts regarding the reduction of accidents of this character was the National Conference at Chicago, on April 30 and May 1 of this year, held under the auspices of the National Association of Railroad and Utilities Commissioners. This meeting was participated in, not only by that organization but by representatives of the American Automobile Association, the National Automobile Chamber of Commerce, the State Highway Departments, the National Safety Council, the railroads and other interested organizations and agencies. The unanimity of thought that found expression at this conference has formed a nucleus around which will be woven something tangible and effective and which will receive the hearty approval of all agencies so vitally concerned in this movement. To those who were instrumental in making this conference possible, as well as profitable, an everlasting debt of gratitude is due, and it is to be hoped that all organizations and agencies, civic, political and otherwise, that are in any manner concerned in the conservation of life and limb, whose aid is so essential in the success of this movement, will continue their splendid work uniting with the railroads in a common enterprise to the end that through a unity of effort there will be a discontinuance of this unnecessary sacrifice of human life.

The foregoing paper by Mr. Hill was presented at the fourth annual convention of the safety section of the American Railway Association at Salt Lake City, Utah, June 24, 1924.

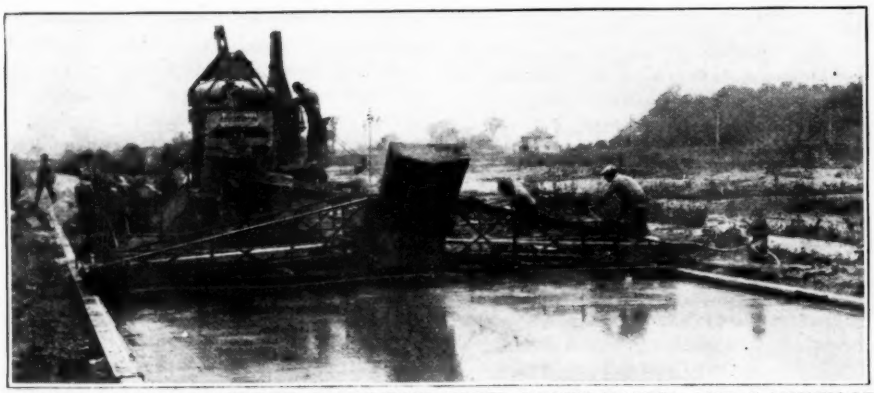
CONSTRUCTION OF CONCRETE STREETS AT BEDFORD, O.

The village of Bedford, Ohio, near Cleveland, has undertaken a good sized program of street construction, and is building a considerable yardage of concrete pavements. ,

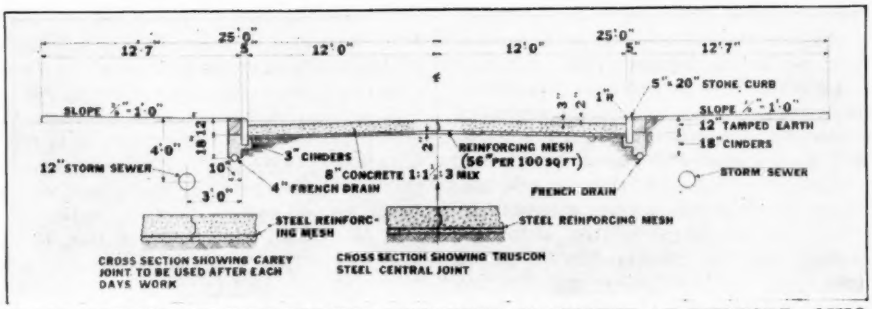
An interesting feature of this work is that the specifications provide that the concrete be spread and tamped mechan ically.

A cross-section of the pavement is shown herewith. On some of the construction a concrete curb is placed instead of the stone curb shown, but in any event, the finishing machine for spreading and tamping must travel on the curbs instead of the steel side forms used for rails on ordinary highway construction.

The method of using the finisher is shown by the photograph. Steel plates, bent to an angle shape, were laid along the top of the curb to protect it. Four



CONSTRUCTING CONCRETE PAVEMENT WITH FOOTE PAVER AND LAKEWOOD MECHANICAL TAMPER AT BEDFORD, OHIO.



CROSS SECTION OF REINFORCED CONCRETE PAVEMENT AT BEDFORD, OHIO.

such plates, each about 10 ft. long were used on each side of the pavement. These are taken up and relaid as the machine advances.

The strike-off and tamper of the machine were fitted with extensions, so that they would operate at the required distance below the tops of the curbs.

It was not possible to use the regular finishing belt of the machine, because the curbs did not allow clearance for it. The final floating of the surface was done with a wood float, extending the full width of the pavement and provided with plow-handles on each end. After the mechanical finisher has spread and tamped the slab, one or two trips over with the wood float completes the job.

The result is a slab of greater density, because of the tamping it receives which drives out air and water voids, and with a smoother riding surface than can be obtained by hand methods.

B. T. Wright, village engineer, in charge of the work.

GRADED MINERAL AGGREGATES OF ASPHALT PAVEMENTS

By J. W. Howard, Consulting Engineer, 1 Broadway, New York, N. Y.

The reasons for definite grading of sizes of the grains of the mineral aggregate of asphalt pavements from the coarsest particles to the finest powder, are almost self-evident. One reason is the necessity of producing a close, dense, uniform mass by having the voids between the larger grains successively filled with succeeding smaller sizes down to powdered mineral in the last tiny voids; also to enable the descending sizes of grains firmly to support the larger ones in position and give stability; resulting in a more uniform and durable pavement than otherwise possible. The invention of preparing definitely graded sizes of crushed stone, sand and powdered mineral, and combining two or more of them into predetermined, numerically graded aggregates, composing 85 to 95 per cent of the pavement composition (15 per cent to 5 per cent being asphalt or bituminous cement) was a distinct and valuable addition to the paving art.

The following quotations from United States Patents 607884 of 1898 and 727505 of 1903 (both expired) clearly show the need of this invention and what it constituted. Grading of the mineral aggregate in asphalt pavement is required by the specifications of the American Society for Municipal Improvements, American Society Testing Materials, American Society Civil Engineers, and practically all cities and states.

Richardson Patent 607884, says: "Heretofore it has never been found practicable to produce pavements uniform in character. * * * I have discovered that the grading * * * in a paving composition, by properly grading * * * I am enabled to lay pavements that shall be substantially alike in all respects and to adopt a formula with the positive knowledge as to the character of the pavement which will result therefrom. * * * A series of sieves is employed known as Nos. 10, 20, 30, 40, 50, 80, 100 and 200 mesh. * * * The largest particles passed by different sieves bear numerical relation to each other. * * * With these sieves, the grading of the *mineral matter* in an asphalt pavement of which it is composed, can be determined and represented in percentages." Claim 1 says: "An artificial pavement composition containing bitumen and mineral matter, in which the latter contains predetermined proportions of different grades."

United States Patent 727505 says: "Employing with larger grains, proper quan-

tities of the smaller sizes down to an impalpable powder, it is possible to reduce the voids in the mineral base (body of the pavement) below 10 per cent of its bulk, and such a mixture when assembled and compacted together will form a dense, solid, homogeneous compact body with the smallest percentage of voids and possessing the highest degree of stability. * * * This density of the structure, stability, and its relative freedom from voids, very much improve the wearing properties of the pavement."

In conclusion, it is evident that predetermined, specified grading or formulæ for such grading for the mineral aggregates of composition pavements, of which any form of asphaltic or bituminous material is the cementing ingredient, cannot be the subject of a patent since 1898 for fine aggregates from 1/10-in. to powder, nor since 1903 for aggregates containing larger particles of mineral to powder.

The foregoing paper by Mr. Howard was presented at the recent annual meeting of the American Society for Municipal Improvements.

THE FINANCING OF ROADS

By A. J. Brosseau, President, Mack Trucks, Inc., 25 Broadway, New York, N. Y.

In any consideration which may be given to highway finance, it has always seemed to me to be fundamental that—

(a) Any investment for highways should not exceed in amount the benefit that accrues to property and society, and,

(b) The increased earning capacity of the highway, together with the reduction in operating costs and maintenance, must be sufficient in amount to pay substantial dividends on the investments.

If we adopt this rule, all expenditures for highways, if wisely made, will increase the wealth of the nation and increase the current income. The owners of property will be benefited by higher land values and the road user will be benefited by lower operating costs. Society, as a whole, will be benefited by the intangibles which come from better education and similar factors. In all directions the evidence emphatically supports the pronouncement of T. H. MacDonald, Chief, United States Bureau of Public Roads, "it will cost less to build roads than to go without them."

How Shall Costs Be Distributed?

Highways will be built. Motor vehicles will traverse them. How are the costs to be assessed in order that the building of highways may be undertaken at once and the burden equitably distributed?

A definite answer is not yet possible. But it is possible to give in outline form, a series of principles which represent a composite viewpoint of eminent highway, financial and motor transport authorities.

It is evident that the first step in any highway program is to survey the field in order to determine upon the roads which shall be constructed. It will be necessary to ascertain how much money will be required to carry out the program so that an annual budget may be set up.

Of course, it is anticipated that the decision arrived at will take into account other public requirements. No government should expend all of its funds for any one class or kind of public improvement.

Classification of Highways Desirable

The next step will be a classification of highways both from an administrative and a construction and maintenance standpoint. Highways are never of equal importance, but a superficial study will disclose relationships which in our country result in a classification of interstate, state, county and local roads.

Naturally the order, kind and extent of the improvement of these highways should depend upon the present and future traffic requirements. In a district where traffic is light all that may be needed will be a graded road with some light surfacing. In sections where traffic will ultimately be heavy, but where the movement is still light and financial resources are inadequate to construct heavy duty highways, the progressive type of road-building can well be adopted. This means providing the permanent features such as the right-of-way, drainage and grading. Time will develop traffic and create property values that will make possible further improvement at a later day.

Improvement Must Be Justified by Returns to Public

In any and all cases, there should be no degree of development beyond the first stage, unless that improvement will more than pay for itself by lessened costs of upkeep, operation and other economic factors.

Comprehensive studies will be necessary to determine these facts and it is hardly necessary to say that the modern highway program presents complexities so numerous as to require skilled leader-

ship of the highest character.

Highways Construction of Benefit to All Society

So much for the planning which should precede the question of finance. In the distribution of costs it will be necessary to take into account those to be benefited and to assess the costs as closely as possible in proportion to benefits received.

The general benefits have been touched upon. They constitute all of those returns which are derived by society as a whole, such as the influences exerted upon education, recreation, health, fire prevention, police protection, the national defense, living and distribution costs—all of those things which are a part and parcel of modern civilization.

Other Carriers Profit Through Road Improvement

Then there are the benefits which are derived by definite routes. The agriculturist, for example, finds his way to market made easier. The manufacturer is enabled to keep his men employed uninterrupted by transportation breakdowns. The railroad derives a new and remunerative tonnage from the goods poured into its stations over the highway.

The property owner whose land lies contiguous to or abutting on an improved highway finds his distance to the city shortened and, in consequence, the value of his land—whether it be used for crop production, or residential purposes—is materially increased.

And again, there is the man who uses the vehicle. The better the highway, the less the energy consumed in moving over it. Consequently, lower cost of operation and maintenance.

Degree of Development Influences Policy to be Adopted

When we get down to the actual consideration of the division of these costs, variables already referred to, will be encountered. A fact frequently overlooked is that highway improvement is not a new question. It is an age old development in many countries. A new territory, state or nation, may have to build entirely new roads. In an older community it may be necessary to improve roads, the permanent features of which already exist.

Suppose we deal with the question first from the viewpoint of a state which is just entering upon the development of its highways. The survey of its engineers determines the mileage and type of roads required.

Long Term Bond Issues Most Economic Solution

Having decided the extent to which roads are to be developed, and having ascertained the amount of funds necessary to carry on the program, it is necessary to consider whether the public should be called upon to bear the entire cost as an annual expense, or whether it would not be more equitable and fair to distribute these costs over a period of years extended beyond the time of the maximum expenditures for a new construction. Inasmuch as succeeding generations will enjoy the use of the highways, which are now being built, it seems fair to pursue a financial policy which will distribute a proportion of the cost beyond the immediate period. No enterprise requiring funds in the large amounts that will be required for the new construction of highways can go forward without anticipation of revenue. In such circumstances the nation, or state, should issue bonds to provide funds sufficient to build all of the main highways necessary to the economic movement of its traffic.

Such bonds should be serial in form, issued only as needed for actual construction, and should mature over a period not exceeding 30 years. Financiers will agree that no mortgage or bond should be issued for a longer period than the life of the improvement. Surveys made by the Bureau of Public Roads developed the fact that more than half the cost of highways is for permanent features—the right-of-way, grading and drainage. The only part of the highway which really wears out is the surface which may be compared to the roof of a house.

Roads Properly Maintained Are Permanent Structures

If the surface is maintained in good repair, the highway becomes a permanent structure and its life is everlasting. It is, therefore, economically sound to issue long time, serial bonds to provide funds to build the highway in the first instance. In this way, the cost of the highway is spread over a long period of years, dividing the cost among several generations, instead of putting the entire burden on this generation. The cost of maintenance is paid by the user as a sort of rental for the use he makes of the road and is a proper charge to current expense.

While it may be claimed that the entire cost of a highway built with the proceeds of a bond issue is greater than would be the cost on a pay-as-you-go plan, the fact

remains that the use of the bond built road, immediately available, more than offsets the interest charge.

Current Funds Generally Sufficient Where Programs Are Well Under Way

In the case of a state where original construction programs are well under way, new construction can probably be financed out of current revenue, utilizing bond issue funds only to defray the cost of special projects.

Finally in those states which have completed their programs of highway construction and are concerned only with the problems of maintenance and reconstruction, current taxation will provide sufficient funds and without unduly disturbing the budget for other purposes.

These principles apply to the primary systems of highways—interstate, state and county. The local roads present a different problem.

The larger political divisions of government should not be expected to bear the cost of construction or maintenance of highways which serve a purely local purpose. Many of these roads are not suited for motor vehicular traffic. Their maintenance by counties and towns often results in little more than keeping them passable, and while the aggregate expense is large, it is only fair to ask those who are the sole beneficiaries to assume the expense of maintenance.

With respect to the cost of maintenance, our experience in this country has demonstrated that the road user is ready and willing to bear the cost of maintenance of the primary system of highways—interstate, state and county. This charge against the user is justified because of the benefits derived by him due to lower operating costs. It is very generally agreed that all special taxes assessed against the motor vehicle user should be set aside and reserved for highway purposes. All such taxes should be assessed by a single agency, preferably the state, and distributed equitably as between the different types of motor vehicles.

Sound Regulation Necessary Corollary to Finance

Since questions of finance often hinge upon regulation it may be well to refer to some important phases of this subject. There is quite general agreement in this country—

(a) Against overloading and overspeeding which endanger life, limb or the highway.

(b) As to seasonal restrictions to protect low type roads.

(c) That the state highway departments shall be the only regulating body.

(d) That regulation be encouraging, not punitive.

(e) That regulation protect the rights of the road user and prevent abuses.

(f) That there be rigid enforcement of motor vehicle laws.

The foregoing is from an address by Mr. Brosseau before the World Motor Transport Congress held in Detroit in May, 1924.

SHIPPERS ENDORSE STORE-DOOR DELIVERY

Store door delivery was endorsed by unanimous vote of some 250 members of the Atlantic States Shippers' Advisory Board at its regular September meeting at the Hotel Commodore. This action followed a favorable report of a special committee which has been studying store door delivery.

The report found that increased flexibility at terminals, through handling of more merchandise and quicker movement of l. c. l. freight, and increased car supply would be the main benefits under a store door delivery plan.

In the opinion of the committee, under a store door delivery plan, delivery must be optional, the carrier must assume full responsibility to and from store door, the cost should be borne by shippers and receivers, the trucking charges must be just and reasonable, reflecting the advantages to the carrier of increased terminal flexibility, and the new system should be established gradually.

While asserting that the United States must eventually come to store door delivery, T. C. Powell, vice-president of the Erie Railroad, said that if store door delivery were installed on an optional basis, it might be difficult to get enough business to make it pay. If the trucking costs are to be just and reasonable, and the rail carriers are to assume responsibility, as urged in the committee's report, a high percentage of the terminal business would have to be handled under a store door delivery plan, he said.

That this high percentage referred to by Mr. Powell would easily be obtained under an optional system was the belief of W. H. Chandler of the Merchants' Association of New York. Mr. Chandler thought that there was nothing in the

law which would permit store door delivery on a compulsory basis, and said shippers would not permit it to be forced upon them. In this opinion, W. J. L. Banham, chairman of the Regional Board, who presided at the meeting, concurred.

The text of the committee's report follows:

At the third regular meeting of the board, held in New York on May 8 last, the executive committee decided that a special committee should be appointed to investigate the possibilities of store door delivery. This special committee was appointed, a study of the subject has been made, and we desire to report as follows:

Your committee understands the purpose of store door delivery is to expedite the movement of freight from and through the terminal of the delivering rail carrier to the premises of the consignee on inbound shipments, or from the premises of the consignor to and through the terminal of the receiving carrier on outbound traffic.

It appears that increased flexibility of terminals is a problem of greater importance and an object of greater desirability than increasing car supply and your committee believes that increasing car supply without increasing terminal capacity will not solve the ultimate problem with which all shippers and carriers are concerned, namely, the relief of freight congestion.

Findings

With this understanding your committee after diligent study finds as follows:

(1) That rail terminals and facilities including freight houses and tracks at points within the board's jurisdiction in most cases were constructed many years ago.

(2) That many of these terminals and facilities have not been enlarged in recent years.

(3) That in most instances the physical handling of freight has not improved to any great extent over methods adopted when the terminals and facilities were originally built.

(4) That the volume of inbound and outbound traffic handled through terminals is constantly increasing.

(5) That such increase in traffic, unaccompanied by enlarged terminals, and improved methods of handling, have resulted in congestion during periods of business activity which has materially increased the cost of handling both to the carrier and to the shipper and has also had the effect of reducing the efficiency of the present car supply.

(6) That a system of store door delivery efficiently conceived, organized and applied where freight terminals are inadequate might reasonably be expected to result in:

(a) A greater volume of merchandise handled through the terminal each working day; and,

(b)) Expedited movement of less than carload freight;

(c) An increased supply of cars.

Recommendations

It is the opinion of your committee that in the establishment of store door delivery, the principles named below must be observed if the system is to be successful.

1. The service must be optional.

Note: (It is the practice in all countries where store door delivery is made in connection with rail service, to give the shipper and consignee the option of handling their own freight from the rail terminal. The necessity for this arises in some cases from the peculiar character of the merchandise. In other cases the shipper or receiver can perform the service cheaper than can the railroad. There are certain commodities which require specialized handling, and it will be neither advantageous to the shipper nor economical to the carrier to entrust the handling of such commodities to inexperienced truckmen.)

2. The carrier must assume full responsibility to and from store door.

Note: (In all countries where store door delivery has been successfully tried, the carrier assumes full responsibility for its truckmen between its terminal and store door. This service must be an extension of the rail service, and it cannot be made successful unless the carrier assumes full responsibility for the agent it selects for the performance of this additional terminal service. If the shipper is to be responsible for the safe conduct of his goods between the railroad terminal and his place of business, it is only natural that he should desire to select a truckman in whom he has confidence and over whom he has some measure of control. In the opinion of your committee this provision is fundamental.)

3. The cost of store door delivery should be borne by shippers and receivers.

Note: (The cost of making store door delivery should be in addition to the station to station rate. The carrier should

not be expected to assume this expense.)

4. The trucking charge must be just and reasonable.

Note: (The charge for the service must be such as to attract the business to the carrier. The charge should reflect the advantages to the carrier of increased terminal flexibility. Unless the trucking charge is at least as low as the present cost to the shipper or consignee your committee believes there will be no inducement to the shipper or consignee to entrust this service to the carrier. Any attempt on the part of the carrier to profit on the terminal service will defeat the object to be obtained.)

5. Store door delivery should be established gradually.

Note: Any attempt to establish store-door delivery in a wholesale way will, in the opinion of your committee, fail. It should be undertaken only at those points where there is obvious need of increased terminal facilities for the handling of less than carload freight. Its establishment should be gradual, and in the opinion of your committee, it should be tried out in some of the smaller cities before attempting to put it into effect in the great markets. This recommendation is made upon the assumption that in its experimental stage some changes will have to be made, and the carriers will gradually develop this method of handling less than carload business, so that when it is established in the larger cities,- the experimental stage will have been passed to a large extent.

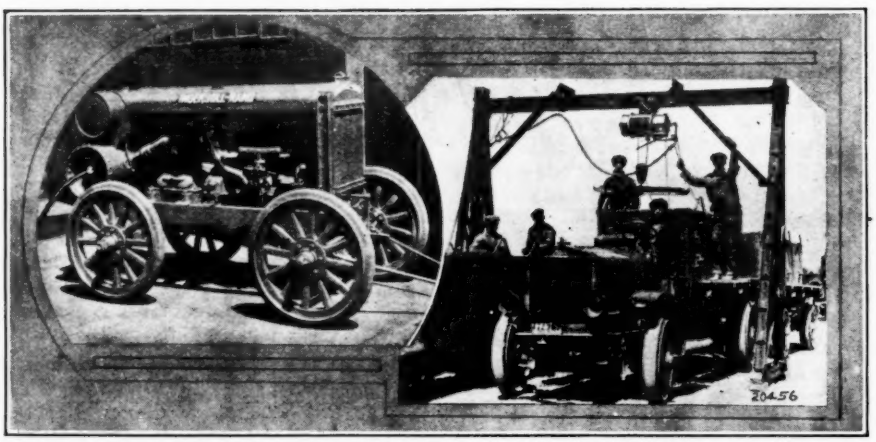
It is the judgment of your committee that a system of store door delivery based upon the foregoing principles is the most efficient means for securing greater flexibility of present terminals and hence increasing car supply.

NOVEL USE OF AIR-DRIVEN HOIST ON ROAD CONSTRUCTION

The Hill & Hill Construction Company was recently building a stretch of concrete highway near East Orwell, Ohio. Roads leading to the work were of such a nature that heavily laden motor trucks could not pass. The task of transporting materials, therefore, presented a very difficult problem, and the manner in which it was solved is interesting.

A railway ran alongside the new roadway; but the use of this means of transportation would involve heavy expenditures if the materials required for the job were to be handled in the usual way by manual labor, inasmuch as it would be necessary to load them first on motor trucks at the storage plant; next to transfer them to railroad cars at the freight yard; and then to place the load once more onto trucks at the scene of operation. The men on this job, however, were used to solving difficult problems.

It was decided to mix the materials at the plant and to transport them in steel hoppers. The lifting of the loaded hoppers on and off the railroad cars had to be done mechanically, and this work was performed by a 4,000-lb.-capacity air-motor hoist drawing operative air from a 4¼x4-in. Type Twenty, portable compressor. This hoist, a product of the Ingersoll-Rand Company, was suspended from an I-beam by a 4-wheel trolley. The



USING AIR-DRIVEN HOIST IN HANDLING LOADED CONCRETE HOPPERS ON ROAD CONSTRUCTION.

I-beam was supported on structural-steel legs—the legs and beam forming a "horse" large enough to straddle both a motor truck and a freight car. This arrangement made it easy to shift the loaded hoist along the I-beam from the freight car to the truck, or vice versa. An air-driven motor was geared to the trolley wheels.

In operation, a slight pull on a chain starts the trolley motor and spots the hoist over the hopper, to which the hook block is then fastened. A slight pull on another chain starts the hoist and lifts the load, while an automatic brake holds it in suspension. A pull on a third chain moves the hoist and its load along the I-beam to the desired position, and a pull on a fourth chain lowers the hopper. In this way, one or two men are able to do the work that would require a dozen men if it were done manually.

SOLVING DRAINAGE PROBLEMS WITH DYNAMITE IN ILLINOIS

The drainage problem is a live problem in many communities for both agricultural prosperity and proper sanitation are very largely dependent upon adequate drainage. Last summer when the ditch that forms part of the drainage system of the Mason City, Illinois, drainage district became so filled up with sediment, growing cattails, flags, rushes and wild rice as almost to stop the flow of water, a serious situation was created. This ditch is depended upon not only to provide drainage for several thousand acres of rich prairie land but also to receive the Mason City sewage from a 30-in. tile pipe, which runs for some distance underground, and to carry it into Salt Creek. In its clogged condition, the ditch became a menace to health.

As the drainage commissioners of the Mason City district were familiar with the use of dynamite for ditch blasting, they employed Charles Patterson, a local blaster, to clean out the ditch.

Mr. Patterson's first step was to cut the lush growth in the ditch so that he could stretch a line along its center. Then he put down a row of holes along this line and loaded them with 60 per cent straight dynamite. About 200 ft. were loaded and shot at a time by the propagation method, which means that the whole shot is fired by one blasting cap in the center hole. When this explodes, the shock passes through the ground and explodes the other charges with such lightning rapidity that the earth is thrown up into the air along the whole line in a single instant, as shown herewith.

The section of the Mason City ditch which had to be deepened runs along the public highway and passes underneath two high tension wires and two wagon bridges. Some apprehension was felt as to the effects of the blasting on these but no damage whatever was done to them. In all, half a mile of ditch was blasted, clearing out a channel 6 ft. wide with sufficient fall to keep the water flowing. The blasts also opened up a spring and two 6-in. tile drains carrying spring water, so that instead of stagnant water hidden by rushes and cattails, there is now a clear channel with water rippling along in the sunshine.

So little equipment is required for ditching with dynamite and the work can be done so quickly that the convenience and economy of this method of solving drainage problems are making it very popular all over the country.

VIEWS ILLUSTRATING THE USE OF DYNAMITE IN DRAINAGE DITCHING IN ILLINOIS

Left: Showing Choked Condition of Ditch Before Blasting. Center: Blasting 200 ft. Simultaneously. Right: The Ditch After Blasting.

RECENT DEVELOPMENTS IN WATER SUPPLY AND PURIFICATION

(Editor's Note: Following is the full text of the report of the committee on Water Supply and Purification of the American Public Health Association. The committee roster is: George W. Fuller, chairman; W. H. Dittoe, G. G. Earl, C. G. Gillespie and Paul Hansen.)

1. Perhaps the item of greatest interest to sanitary workers in the water supply field is the decision of the Supreme Court of the state of Pennsylvania reversing the decision of the trial court which denied an injunction in the coal mine drainage suits. The Mountain Water Supply Company which supplies the Pennsylvania Railroad system in southwestern Pennsylvania owns a large impounded reservoir on Indian creek above which are numerous coal mines owned by the Melcroft Coal Company and other companies. These coal mines discharge acid water into Indian creek above the reservoir. The county court denied the injunction but the Supreme Court has very recently directed that an injunction be issued against the pollution. It reviews in an interesting way various other precedents and also deals with the rights of riparian owners. It states that "it has always been under our (Pennsylvania) law a nuisance to pollute a stream from which the public gets its water supply." These proceedings deal with the application of the common law and not the violation of any statutes. Whether or not this suit is appealed to the Federal courts it is bound to make important history in the matter of control of pollution as relates to protection of public water supplies.

2. The application of an iodine salt to the water supply at Rochester, N. Y., during two weeks each year has been continued. The procedure has received much discussion and has developed its strong proponents and opponents. There does not seem to be much, if any, room for doubt about small amounts of iodine salts, taken internally, constituting a preventive of- simple goiter. Opinions vary, however, as to the best form in which to supply this substance. While discussions of interest and importance are pending, data are being accumulated to show the location and extent in the deficiency of iodine in various sections of the country, particularly around the basin of the Great Lakes system. Although this general locality seems to be an area where water supplies are low in iodine it should not be taken for granted that all water supplies in this area are deficient in this element; neither should it be assumed that there is no deficiency in the salts of iodine in waters from localities far removed from this area.

3. Water purification programs have continued to proceed on a large scale and at many places. During the past year water filters have gone into service at Detroit, Omaha, Sacramento, Memphis and Richmond, as well as at numerous smaller cities. Many other large cities are proceeding with enlargements to existing filter plants and, generally speaking, it may be said that gratifying progress is being made in the application of the art of making public water supplies pure and wholesome. In 1923 extraordinarily high turbidities were encountered in many river waters, particularly west of the Mississippi. This has caused much study to be given to means of removing sediment continuously from settling basins with the aid of mechanical devices, rather than by the earlier custom of emptying basins and flushing the accumulated mud from them. The latter custom, in vogue for generations, proved very bothersome in the late summer and fall of 1923 at Omaha and elsewhere and interfered seriously with the normal quality of the supply. The continuous cleaning arrangements under consideration are similar to those used in cleaning sedimentation tanks used in sewage treatment and in water softening processes.

4. Interest has been revived in studies of the filtering media of rapid sand filters by the recent announcement of work done at Baltimore, showing an unsuspected biological activity associated with the sand clogging.

5. Water softening has received more attention than has been the case for some time previously. A plant of 20 million gallons capacity has been put in service at South Pittsburgh, in order to make suitable a water supply derived from the Monongahela River with its well-known acid content from coal mine drainage during certain months of the year. At this point, as well as at the softening plant at Benton Harbor, Mich., arrangements are installed for the continuous removal of sediment from the basins. In the water-softening field one of the leading questions for consideration is that of re-

carbonating the softened water in order to avoid lime accretions in the pipe system. Good results have been reported at Defiance, Ohio, where coke is burned in a special furnace to produce carbon dioxide necessary for recarbonation. At South Pittsburgh the softened water receives a predetermined quantity of untreated raw water. At Columbus consideration is being given to utilizing the gases from the smoke stack of the pump station for recarbonating the softened local supply.

6. Along with the demand for a better quality of water, and improvement in purification facilities, there is coming to be recognized to an increasing extent the responsibility of the water department for good physical qualities of the water as drawn from the consumer's faucet. This means that adequate purification at the plant is not in all cases sufficient where the water is made attractive and of good bacterial quality. The behavior of the water in contact with the distributing mains, service pipe and plumbing often causes annoyance to the consumer on account of rusty water; and at a number of water works plants it is found necessary to extend the water treatment in order to combat the tendency towards corrosion. Baltimore is a well-known example. At Memphis the removal of a very high content of carbonic acid by means of aeration incident to removal of iron produces a non-corrosive water which is very gratifying in contrast, with former conditions. Another feature of the corrosion subject is that of the possible action of the water on lead service and plumbing and the imminent danger in some water supplies of harmful effects upon consumers on account of plumbism. This is an old story but the basic facts are unescapable and the subject needs to be rehearsed as long as danger exists.

7. Aeration has been made a feature of some recent purification plants as at Norfolk, where a long spilling table with splash steps has been provided; at Richmond, where a bank of spray nozzles has been used; at Cambridge, where the riffle board idea is employed, and at Sacramento, where use is made of a novel form of self-adjusting or "floating" nozzles. These devices all deal with surface water and are aside from the aeration provided at certain iron removal plants. Mention also should be made of the aeration employed in certain Ontario plants, using compressed air applied through a diffuser plate.

8. Committees acting for the Treasury Department are still engaged in formulating a new standard for judging the quality of water supplied on interstate carriers. The tentative standard has already been offered for public discussion by technical bodies, but a final recommendation has not been announced nor a new standard promulgated.

WATER PURIFICATION FOR SMALL CITIES

By H. V. Pedersen, State Sanitary Engineer, Des Moines, Iowa

Is it practical for a city as small as 1,000 population, so unfavorably located as not to be able to secure a sufficient quantity of safe and palatable water for public use from wells, to consider the installation of a purification plant and develop a surface water supply? Anyone answering this question definitely either negatively or in the affirmative, might be accused of rather hasty decision as one answer might be just as correct as the other. The correct answer as applied to a particular community depends largely upon local conditions, and should not be made until all of the determining factors have been carefully studied. But I shall go as far as to say that when a small city has become thoroughly dissatisfied with its old well supply, and determines on a change, the development of a surface supply should in all cases be at least considered.

Every city, regardless of its size, should choose or develop the safest, most palatable, and most practical water supply for public use that it can. Some few cities in Iowa are so favorably located that they have no problem whatever in securing an excellent public water supply. Nature provided an abundance of clear safe water within easy reach, and the city officials of the past only needed to dig a well, install a pump and pay the power bills to fulfill the duties of their offices. It was so easy that it required no thinking, and it cost so little that the general public came to take it all for granted.

Many other cities, however, have not been so favorably located. Nature was not so kind to them, and they have been compelled to spend large sums of money developing a well water supply. Although the State as a whole has been blessed with an abundance of under-

ground water, there are sections where this water can not be considered a satisfactory public supply, because of the mineral content and objectionable tastes. Many of the shallow water-bearing sands are loaded with iron, and many of these sands lying beneath or adjacent to a city or town do not produce a bacteriologically safe water supply at the present time.

Iowa Conditions

The northern half of the State is generally thought of as having an inexhaustible supply of unquestionably safe underground water. There is no question but that there is a large quantity of water but it is amazing how rapidly this water is diminishing. Just what may be the cause of the lowering of the water table is difficult to say ,but we are inclined to believe that it is due to the fact that the underground water is being used up in a wasteful manner faster than it can be replaced.

The greater part of the Northern half of the State is underlaid with a limestone formation. A well drilled down into this formation years ago was rarely cased below the stone. Many cracks and crevices have gradually opened, and enlarged, due to erosion and exposure, allowing unpurified surface water to pass for long distances and contaminate a vein of water that has furnished the public water supply. The majority of these deep wells produce a very hard water. Some of the waters are so hard and are so full of iron, carbon dioxide, and other corrosive agents that the life of the best well casing is not over 20 years. Thus it is that many deep wells which were once perfectly safe, now produce a water which is contaminated, and rendered unsafe from sources that are beyond human control.

Some Iowa towns have been trying for years to develop a satisfactory well water supply. In the southern part of the State some cities have not been able to locate an adequate well supply, and have therefore simply done without a public water system. Three cities within the last year, located in the southern half of the State, installed water purification plants as a result of long years of waiting. In the northern part of the State many towns have been getting along as best they could on a hard, disagreeable tasting water for the reason that they believed there was nothing that could be done or that there was no way to obtain a more palatable water supply. Several cities within the last year have installed softening and iron removal plants, which have proven satisfactory. The great majority of the towns, however, have continued to use a hard impalatable, unsafe and an altogether unsatisfactory well supply because they are under the impression that it is impracticable or impossible for them to consider the development of a surface supply, or do anything to improve their well supply.

For the benefit of those small cities in the State so located that they can not secure a good underground water supply, I am going to relate the experiences of several cities, that have taken place within the last few years.

At Adel, Iowa

The city of Adel, with a population of about 1,500, did its best for years to put up with a shallow well water that contained a great deal of iron, was hard, and was afflicted with a disagreeable taste. Finally the public refused to stand it any longer, and the council decided to make every effort to secure a more satisfactory supply. All of the available underground supplies in the near vicinity were located and tested with little success. After a careful search a good shallow water-bearing sand was located about 1¾ miles from the city, which furnished an excellent water. After the council had deliberated and carefully considered the advisability of treating the water in the original old well, and the development of the new shallow well proposition, it finally decided to construct a small rapid sand filter plant and purify the water from the Raccoon River, on whose banks the city is located.

A contract was entered into, and as a result the city now has a 120,000-gal.-per-day purification plant. The water is first pumped from the river to a small aerator, from which it flows by gravity into a coagulation basin 9 ft. wide, 32 ft. long and 12 ft. deep, where the water is treated with alum and allowed to settle. From the coagulation or settling tank the water flows by gravity through a sand filter 5 ft. wide and 8 ft. long, to a clear well beneath. This clear well has a capacity of about 4,000 gals. From the clear well the water is pumped into the distribution system, which includes a storage or pressure tank. Liquid chlorine is injected into the water at the intake of the high-duty pump to insure sterilization.

There is little question but that an argument might be raised as to the wisdom on the part of the city to install the above-described plant in preference to developing the shallow water-bearing sands located 1¾ miles distant. It can not be denied, however, that a very fine little filter plant was secured at a total cost of about $11,000, complete, including a Wallace & Tiernan chlorinator. As it was estimated that it would cost in the neighborhood of $25,000 to develop the shallow well proposition, it is evident that the city made a considerable saving as far as first cost was concerned. Viewed from the eyes of the public, the city council secured a good filter plant capable of furnishing a soft, clear, safe water for public use at a saving of $12,000 or more and it is satisfied.

At Sigourney

Now let us consider the city of Sigourney. This city, like Adel, also had its past troubles, but its experiences were of an entirely different nature. It seems that on the advice of some local genius a council some years ago carried a water main a good five miles distant to a small river, where a natural purification plant was to be developed. To make a long story short the attempt to develop a natural filter was a complete failure, due entirely to improper advice and design. As no other supply was available, and as the resources of the town had been completely drained, the city had to put up for years with a very unsatisfactory, dirty, raw river water that could not be used for drinking or culinary purposes.

Finally a city council determined to secure a better water supply, and they brought in a number of cnosulting engineers to advise them. Three engineers out of four advised the council to install a modern rapid sand filter plant, on the grounds that the deep well water would contain a great deal of objectionable mineral salts which would cause a taste. No amount of advice could move the council, or overcome the memories of the past sad experiences, and a contract for a deep drilled well was let. The deep well, drilled within the city limits, a pump house, and pumping equipment was installed for approximately $30,000. As predicted, the water from this well is very hard, and contains such an amount of mineral salts that it can not be considered satisfactory for drinking purposes. The public is dissatisfied with the result and prefers to use private shallow contaminated wells in preference to the public supply.

Two Mistakes

The city of Adel might have been able to develop a good shallow well supply, but they chose to treat or purify a surface water which in this case was the cheaper method. Sigourney might have developed an excellent surface water, but chose to develop the hard, impalatable deep water at great expense because they believed a surface water could not be purified fit for drinking purposes no matter what it might cost.

Comparing the first cost of a filter plant and a development of a surface supply with a well proposition, it might be said that the former will as a rule demand a greater outlay of money. Natural conditions in some places tend to make exceptions to this rule as in the case of Adel. In places where a well supply is impossible a good surface supply is cheap at any price. Judging from the number of small cities that have been able to develop a surface supply successfully we feel that it is safe to assume that the first cost is not prohibitive and that what one small city can do, another might also do.

Filter Operation Not Difficult

The one chief argument which discourages the development of a surface water supply is the operation. No one can deny that a water purification plant must be given careful, intelligent attention, or it will prove a failure. I do wish to emphasize, however, that a small city need not think that it must necessarily employ a high-priced engineer to operate a water purification plant. A conscientious, industrious, intelligent man may be placed in charge, and taught in an amazingly short time all there is to know. In the small city a plant may need be operated but half of the day. The operator might therefore be a commissioner of streets, or be given some similar office, whose duties can work in well with his duties as operator. It is evident that the larger the plant the more time is required for operation, and naturally the various problems increase in magnitude, but the point is that a good, intelligent local man, if he is the right man, can be developed into a competent operator in a surprisingly short time if given an opportunity. No small city need continue to be without a public water supply, or use a bad well water for fear that they cannot find a man to operate a puri-

fication plant in a successful manner, provided they are willing to pay a fair salary.

Cost of Operation

The question of cost of operation also enters into the problem of deciding whether the development of a surface supply is practicable. Much can be said on the subject, and it is no doubt true that it would cost more to operate a purification plant in some places than it would to operate a well supply. Every water works system, no matter how simple it is, must have some sort of a caretaker in charge. The majority of the public water systems of Iowa have a caretaker who devotes all the way from 1 to 24 hours per day. It is not necessary to increase the number of men to take care of the average small city purification plant. The same intelligent caretaker who can take care of a well system, could with a little more time take care of a properly designed purification plant. At Adel the operator spends about one-half of his time at the plant, the rest of the time he is taking care of extensions or acting as assistant street commissioner. It seems, therefore, that although the cost of operating a purification plant is greater than a well system, it can not be said that the cost is excessive or prohibitive.

The old idea that it is not practicable to develop a surface water supply should be corrected. Naturally when a small city is so favorably located that it can secure a cheap, satisfactory well water it would be foolish to consider the development of a surface water supply. I am not thinking of such cities, but I am thinking of cities that are finding it difficult to secure an adequate, satisfactory well supply. The people of the State of Iowa should be told that the underground water supply is rapidly diminishing and that it is only a matter of time when it will be exhausted in some places. The public should also know that the well supplies of many Iowa municipalities have for years shown a marked increase in the amount of objectionable impurities present in the water. It is not right to encourage a municipality to drill one costly deep well after another by discouraging the development of a surface supply.

It has been definitely proven in other states as well as our own that the purification of a surface water supply is practical, and I wish to go on record as believing that when a city of 1,000 population and upward is dissatisfied with its public water supply it should at least consider the development of a surface supply before it spends a great deal of money in developing or adding to an already unsatisfactory supply.

The foregoing paper by Mr. Pederson was presented before the annual meeting of the Iowa Section of the American Water Works Association, at Iowa City, Nov. 6-8, 1924.

IMPROVEMENT OF SETTLING BASINS OF DAVENPORT WATER COMPANY

By Wm. H. Kimball, Consulting Engineer, Davenport, Iowa

In 1901 the Davenport Water Company constructed at its main pumping station on the Mississippi River a concrete sedimentation basin with a capacity of 3,700,000 gals. This basin is somewhat irregular in shape, this being necessary to accommodate it to the available land. Its total legnth is about 470 ft., its width at the west end 128 ft., and at the east end 67 ft. The average depth of water in the basin is about 12 ft.

This basin as built had no division walls or baffles and has been in continuous use since it was built. The water from the river is pumped through a 24-in. cast-iron pipe which discharges near the east end of the basin. The sulphate of alumina used as a coagulant, enters this 24-in. pipe beyond the west end of the basin, and the water from the sedimentation basin passes from it to a battery of 12 pressure filters, located in the filter building to the west. The plant has always been carefully operated, and water of an excellent quality has always been furnished, although within a few years after the sedimentation basin was put into operation it was realized that better results could be obtained from it if it were divided into two or more compartments, and plans for such a division were prepared prior to the war. Finally, late in 1922, a plan for a wall dividing the basin transversely into two approximately equal compartments was approved, and in March, 1923, a contract was made for this construction. The division wall was built in September, 1923.

A section of the wall forms a deep, narrow trough, the water from the east part of the basin flowing into this trough

over the top of the concrete wall which forms a weir.

After entering the trough the water flows downward, along the whole length of the wall, to an opening controlled by a 30-in. gate valve at the center of the wall and near the bottom. In an emergency it is possible by opening another 30-in. valve to pass the water directly from basin No. 1 to basin No. 2.

The hollow space within the division wall may be provided with baffle planks still further to regulate the flow to the gate valve, although these baffles have not been installed.

It will be apparent that drawing the water from the east basin over a shallow weir practically the full width of the basin, creates a slow, even and undisturbing flow, so that sedimentation in the east basin is very complete.

The water enters the west basin or No. 2, in a clear condition, and flows from No. 2 into No. 3, which is a small semicircular basin, where it is given a final dose of sulphate of alumina before going to the filters.

At all times a dose of chlorine is also given the water in basin No. 3.

After the construction of the division wall in September, 1923, the following summary of the new plan of operation was prepared by the Davenport Water Company:

Quantity of sulphate of alumina used, in grains per gallon, monthly averages, for the twelve months immediately preceeding construction of cross wall (Col. 1), for the twelve months immediately succeeded construction (Col. 2) and the average for the 14 years ended Jan. 1, 1924 (Col. 3).

Month	Col. 1	Col. 2	Col. 3
October	2.56	2.74	3.33
November	2.19	1.59	2.72
December	2.24	1.49	2.30
January	2.21	1.24	2.23
February	2.56	1.68	2.80
March	3.07	2.57	3.72
April	3.51	2.68	3.15
May	2.82	3.25	3.45
June	4.08	4.17	4.23
July	5.40	4.02	4.09
August	4.34	4.13	4.05
September	4.07	3.11	3.69

The cross wall was completed and basin put in service September 28, 1923.

Turbidity

The turbidity of the raw water for the twelve months after the wall was constructed was generally higher than during the twelve months preceding, especially so in the months of June, July and August. The average turbidity of the water treated with alum recorded in column 1 in June, July and August was 187, 211 and 113 respectively, while in the same months in 1924 the average turbidity was 326, 382 and 450 (Col. 2) showing that less alum was used to treat water having much higher turbidity. The maximum turbidity in August, 1923, was 275 (Col. 1) the maximum turbidity in August, 1924, was 900 (Col. 2).

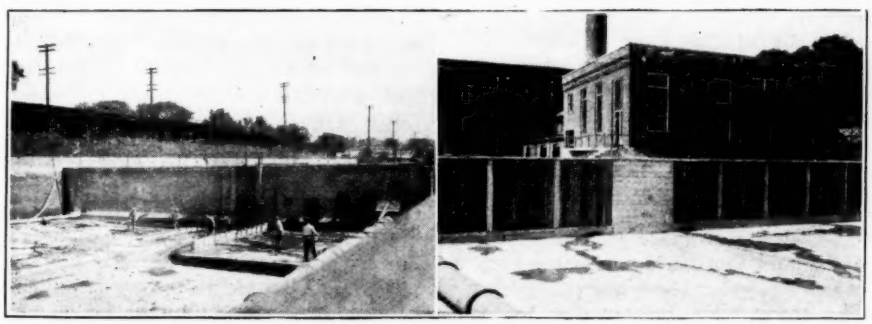
In August, 1923, the average number of colonies counted on Agar at 37 degrees was 19,600 for raw water and 14 for filtered water. In August, 1924, the corresponding figures were 13,400 and 16.

It should, however, be stated that the quantity of sulphate of alumnia used here is not governed directly or entirely by the turbidity. Other factors such as algae and bacterial pollution sometimes control in determining the proper dose of chemicals.

Additional Improvements

During the winter of 1924 plans for additional improvements to the settling basin were prepared, and these plans were carried out in September and October, 1924.

These improvements included a mixing chamber, and chemical storage house adjoining the division wall in Basin No. 2



IMPROVEMENTS IN WATER SETTLING BASINS AT DAVENPORT, IOWA.
Left: Division Wall with West Basin Empty. Right: Closeup View of Baffle.

and a baffle frame and baffles extending entirely across the west end of Basin No. 2, together with a valve box or chamber into which the water enters after passing the baffles.

Mixing Chamber

The mixing chamber is of reinforced concrete, 12 ft. wide, 30 ft. long and 12 ft. deep. It is provided with brick baffle walls about 30 ins. apart extending to just above the water surface. These baffles aid in efficient mixing of the chemicals with the incoming water from Basin No. 1.

The mixing chamber is covered with a reinforced concrete slab, and is entirely enclosed on top by a brick superstructure.

Baffle Frame

The baffle frame at the west end of Basin No. 2 is of reinforced concrete with 1½x6-in. cypress baffle planks. Its purpose is to prevent direct flow through Basin No. 2 to the outlet, the baffle openings being so proportioned that the flow takes place along the entire length of the baffle.

The valve chamber was a necessary adjunct to permit and control the flow back of the baffle into Basin No. 3. It is built of reinforced concrete and provided with two 24-in. gate valves and operating stands.

Concrete Work

The designs of the reinforced concrete work were all quite simple and present no unusual features. There was no attempt made to build the lightest sections posssible. On the contrary the work is all substantial.

All of the cement used in the work was tested at the University of Iowa. Sand, gravel and stone were carefully selected, and in part of the work, such as the division wall, were carefully graded.

Proportions were 1:1½:3 for the division wall, and 1:2:4 for the rest of the work. All of the work is water-tight, and all submerged steel is protected by at least 3 ins. of concrete. No waterproofing compounds were used nor required with the carefully graded mixtures employed.

The Priester Construction Company of Davenport were the contractors for all of the work and deserve credit for the rapidity and thoroughness with which it was done.

The plans were largely due to local conditions and followed the design of the basin which was piped for an expected division at the time of original construction. Observations and experience of the operators were also considered in the final arrangement.

The engineering features of the work, the designs, the preparation of the plans, specifications and contract, and the carrying out of the construction were under the personal supervision of the writer. Credit for the odiginal ideas incorporated in the design of the division wall should go to Mr. Charles R. Henderson, manager of the Davenport Water Co.

The foregoing paper by Mr. Kimball was presented before the recent annual meeting of the Iowa Section of the American Water Works Association.

SURVEY OF STREET LIGHTING PRACTICE IN THE UNITED STATES

By J. Franklin Meyer, Physicist, Bureau of Standards, Department of Commerce, Washington, D. C.

(Editor's Note: This paper by Mr. Meyer was presented before the annual convention of the Illuminating Engineering Society, Briarcliff Manor, N. Y., Oct. 27-30, 1924. It is published with the permission of the Director of the Bureau of Standards).

A comprehensive survey of street lighting practice has been in progress for some time by the Bureau of Standards, and this paper is a preliminary statement of some of the results obtained. It has been made possible only through the cordial co-operation of the operators of electric light and power systems, municipalities, and the manufacturers of street lighting equipment.

Electrical Street Lighting

The survey has been confined almost entirely to the electrical aspects of street lighting. It has been possible to obtain only very meager information on gas lighting and practically none on oil, acetylene, and gasoline lighting, although these types of street lighting are still used in many cities, even in some of the largest. No attempt has been made to make field measurements of illumination, nor have the artistic and esthetic aspects been given consideration. The main purpose has been to ascertain as fully and completely as possible the present standards of electrical street illumination in cities of 10,000 population and over, omitting, however, all cities of population in excess

of 500,000, since in these very large cities conditions are special and unique. A series of questionnaires was carefully prepared and submitted to the 730 cities listed in the population bulletins of the Bureau of the Census, 1920.

Scope of Investigation

As it was obviously impossible to cover all phases of street lighting practice in American cities, the questionnaires were limited in scope to four of its leading aspects, (1) general information as to total mileage illuminated, total kilowatthours sold for street lighting and total revenue received; (2) details as to number, types and sizes of lamps installed; (3) details of a mile of street having maximum illumination; and (4) details of a mile of street having minimum illumination. Construction, installation, and operating practice has been obtained from a considerable number of the larger utilities that very kindly furnished the Bureau with blueprints and specifications covering details of their street lighting systems. Street lighting contracts have been furnished by a large number of municipalities, and numerous private contracts and methods for financing privately owned installations were communicated to us.

Replies Received

Replies to the questionnaires were received from 362 cities, or approximately 50 per cent. Upon receipt each questionnaire was very carefully checked for possible discrepancies. Those which showed apparent discrepancies were corrected or in some cases returned for further information. I twas realized that to answer all the items asked for, required considerable labor on the part of the utility or municipality concerned, and great credit is due the co-operating utilities for the painstaking care with which the responses were generally made out.

Mixed Ownership

It is believed that the results give a fairly representative cross-section of street lighting practice in the United States. It is not possible to say how many cities are lighted by municipally-owned and operated plants, and how many by public-utility plants. Almost every imaginable combination of utility, municipal, and community operation exists, and there are few cities where the local utility corporation owns and operates the entire street lighting system, or where the municipality owns and operates the system completely. Individual business men, associations of merchants and citizens and local city communities may own the lighting equipment, either entirely or in part; the city may own the distributing system and the lamp posts, while the lamps and accessories are owned by the utility or conversely. On the same street there may be two separate systems or business arrangements for lighting as between the municipality, merchant's association an dthe local electric light and power company. No standard practice can be said to exist in this respect.

The 730 cities having populations between 10,000 and 500,000 were arranged in ten groups as shown in Table I. More than half the cities fall in group ten, viz., 10,000 to 20,000 population, and 67 per ecnt in the ninth and tenth groups. Only in group ten is the range of population as great as two to one. The purpose has been to group cities so that essentially the same illumination requirements would be applicable. Of the 362 cities from which replies were received, 219 or 60 per cent fall in the groups of 30,000 population and under.

Table II shows average values for the total load in lamps installed, the total energy consumption including losses, the percentage of arc lamp and incandescent

TABLE I—RANGE OF POPULATION, NUMBER OF CITIES, AND THEIR GROUPING

Group number	Range of population	Average population of group	Total number of cities in group	Number of cities from which data were received
1	300,000 to 500,000	376,000	9	6
2	200,000 to 300,000	236,500	12	9
3	150,000 to 200,000	169,500	10	8
4	100,000 to 150,000	122,000	26	12
5	75,000 to 100,000	87,500	25	15
6	50,000 to 75,000	60,900	53	30
7	40,000 to 50,000	44,400	40	26
8	30,000 to 40,000	34,400	65	37
9	20,000 to 30,000	24,100	108	54
10	10,000 to 20,000	13,750	382	165
	Total		730	362

TABLE II—THE AVERAGE STREET LIGHTING LOAD AND ENERGY CONSUMED PER YEAR IN LIGHTING STREETS OF CITIES OF VARIOUS GROUPS

The percentage of load in arc and incandescent lamps was obtained from the total group load and is not an average

Group number	Kilowatts of lamps installed	Kilowatt-hours. Total including losses	Per cent of total group load		Miles illuminated	Kilowatts per mile
			Arcs	Incandescents		
1	1945	8,260,000	59	41	622	3.4
2	1275	5,460,000	40	60	398	3.4
3	682	3,120,000	29	71	332	2.3
4	592	2,490,000	55	45	172	3.7
5	420	1,750,000	40	60	194	2.5
6	295	1,150,000	24	76	136	2.5
7	208	925,000	20	80	87	2.9
8	162	657,000	28	72	77	2.6
9	109	437,000	27	73	64	2.1
10	69	287,000	20	80	41	2.0

TABLE III—AVERAGE RESULTS BY CITY GROUPS

Group	Average population	Miles illuminated	Population per mile of street	Lumens per mile	Lumens per capita	Annual cost per mile	Cost per capita
1	376,000	622	656	57,600	86	$558	$0.85
2	236,500	398	633	62,800	91	604	.93
3	169,500	332	560	38,800	68	427	.74
4	122,000	172	760	53,200	69	708	.86
5	87,500	194	510	41,300	82	487	.93
6	60,900	136	540	40,700	80	474	.94
7	44,400	87	658	47,500	78	554	.94
8	34,400	77	544	43,700	79	471	.91
9	24,100	64	479	36,200	74	414	.90
10	13,750	41	410	30,000	74	408	1.02

TABLE IV—RANGE OF ILLUMINATION ON MOST BRILLIANTLY LIGHTED STREETS

The average values in lumens per foot are given for the cities in each group, together with the highest and lowest values. The average lumens per foot for all streets are given in the last column, for purposes of comparison

Group	Lumens per foot of street			Percentage of cities exceeding average	Average lumens per foot for all streets
	Average value	Highest value	Lowest value		
1	117	220	25	34	11
2	155	292	75	44	11
3	128	196	66	43	7.4
4	130	523	25	34	10
5	152	241	80	57	7.8
6	128	415	15	38	7.7
7	94	314	8.3	44	9
8	95	227	9.8	42	8.3
9	77	253	1.2	46	6.9
10	66	272	0.9	44	5.7

TABLE V—RANGE OF ILLUMINATION ON WORST LIGHTED STREETS

The average values in lumens per foot are given for the cities in each group, together with the highest and lowest values. The average lumens per foot for all streets are given in the last column, for purposes of comparison

Group	Lumens per foot of street			Percentage of cities exceeding average	Average lumens per foot for all streets
	Average value	Highest value	Lowest value		
1	7	16	2.0	50	11
2	12.3	49	1.2	38	12
3	3.7	6.8	1.9	50	7.4
4	16.1	38.6	1.9	36	10
5	6.2	22.7	0.7	36	7.8
6	10	79.0	0.7	43	7.7
7	9.5	53.5	1.4	35	9
8	7.8	19.3	0.6	46	8.3
9	7.0	38.0	0.3	39	6.9
10	4.9	19.3	0.5	36	5.7

lamp load and the load per mile of illuminated street. The energy consumption is based on a 4,000-hour annual operation. However, a large percentage of street lighting lamps are operated on a part time schedule so that the results given are maximum figures.

The results given in Table III are all on the basis of averages for each group of cities and should be compared with

the figures tabulated in Tables IV and V, where maximum and minimum values are given. Lumen values are calculated from manufacturers' mean ratings for each type of lamp reported. The second column in Table IV gives for each group the average amount of light in lumens per running foot provided on the best lighted streets of all the cities in the group while the third and fourth columns give the largest and smallest amounts furnished by individual cities for their best streets. For example, Table IV shows that the maximum amount of light provided in any city of Group 2 (200,000 to 300,000 population) is 292 lumens per running foot, but that 75 lumens per foot is the maximum furnished in another city in the same group, while 155 lumens per foot is the average of the best lighted streets of the whole group, with a general average of 12 lumens per foot for all cities of the group when all streets are included. Similarly from Table V, the lowest level of illumination in any city of Group 2 is 1.2 lumens per linear foot, but the best lighted city of the group does not go below 49 lumens per foot.

The results tabulated in Tables IV and

TABLE VI—LUMENS PER SQUARE FOOT OF STREET SURFACE, MAXIMUM AND MINIMUM

	For best lighted streets			For worst lighted streets		
Group	Average value	Highest value	Lowest value	Average value	Highest value	Lowest value
1	1.77	3.3	0.33	0.126	0.23	0.032
2	2.21	3.0	0.98	0.135	0.31	0.030
3	1.88	2.6	1.10	0.070	0.09	0.038
4	1.60	4.7	0.37	0.279	0.75	0.046
5	2.12	4.0	1.24	0.159	0.67	0.009
6	1.95	4.3	0.29	0.170	1.25	0.019
7	1.53	4.6	0.16	0.170	1.00	0.020
8	1.42	4.2	0.20	0.135	0.36	0.036
9	1.33	4.6	0.04	0.140	0.73	0.015
10	1.04	4.0	0.02	0.093	0.61	0.008

TABLE VII—WATTS PER LINEAR FOOT OF STREET

	For best lighted streets			For worst lighted streets		
Group	Average value	Highest value	Lowest value	Average value	Highest value	Lowest value
1	6.8	11.4	2.0	0.42	0.88	0.15
2	8.9	16.5	4.1	0.72	2.60	0.09
3	8.2	15.1	4.0	0.24	0.42	0.13
4	7.5	29.0	1.5	0.87	2.34	0.15
5	9.0	17.8	4.4	0.42	1.80	0.06
6	7.8	21.0	0.9	0.58	4.80	0.05
7	5.6	17.8	0.5	0.59	3.20	0.10
8	5.9	12.6	0.6	0.50	1.75	0.06
9	5.0	13.7	0.1	0.42	2.50	0.02
10	4.4	15.8	0.08	0.30	1.17	0.04

TABLE VIII—AVERAGE ANNUAL COSTS IN DOLLARS AT VARIOUS ILLUMINATION LEVELS

			Average cost per foot of street lighted						
			Highest level			Lowest level			Average for all cities in group
Group	Cost per capita	Average cost per mile	Max.	Min.	Avg.	Max.	Min.	Avg.	
1	$.85	$558	$2.07	$.55	$1.19	$.10	$.03	$.07	$.11
2	.93	604	2.04	.79	1.31	.28	.04	.12	.11
3	.74	427	1.45	.75	1.10	.07	.03	.05	.08
4	.86	708	2.20	.38	1.08	.34	.05	.15	.13
5	.93	487	1.94	.78	1.25	.27	.015	.09	.09
6	.94	474	2.00	.17	1.04	.16	.02	.09	.09
7	.94	554	1.84	.07	1.02	.19	.03	.09	.10
8	.91	471	1.73	.22	.86	.26	.02	.11	.09
9	.90	414	1.93	.05	.68	.21	.005	.07	.08
10	1.02	408	2.04	.05	.72	.18	.01	.07	.08

TABLE IX—RATIO OF SPACING DISTANCE (MEASURED BETWEEN ADJACENT UNITS ON ONE SIDE) TO MOUNTING HEIGHT

1	6.0	7.3	10.0	21.0	32.0	44.0
2	4.2	8.4	23.0	9.0	22.0	44.0
3	5.4	6.7	8.7	16.5	34.8	79.0
4	4.0	9.0	19.8	10.0	20.1	40.0
5	4.4	6.5	9.2	11.4	23.7	41.9
6	3.9	7.3	25.5	11.3	22.4	40.0
7	3.6	8.1	20.0	8.3	21.2	60.0
8	5.0	7.6	16.0	6.7	21.1	35.0
9	4.0	9.3	33.0	8.0	24.5	85.0
10	....	....	.....	.....	.....	.....

V are given on the basis of length of street lighted, no consideration being given to the width of the streets. In Table VI the same data are expressed as the ratio of the lumen rating of lamps installed to the area of street surface illuminated. The third colmn giving the maximum values found in the ten groups shows a surprising agreement in values. The ratio of spacing distance between adjacent units to the mounting height is an important factor in determining uniformity of street illumination. The range of ratios reported is shown in Table IX.

LIME IN THE TREATMENT OF TRADE WASTES

By R. H. Ferguson, Lime Fellow, Ohio State University, Columbus, Ohio

Trade wastes are the various liquid effluents from manufacturing processes. That is the technical definition.

Sewages contaminated with various kinds of liquid discharges which are commonly called trade wastes have become a major problem to engineers and manufacturers during the past three or four decades.

In the year 1909, Fuller (1)* called attention to the fact that chemical precipitation had a large application in this field, especially as a preparatory treatment, although consideration at that time was centered mainly around certain biological treatments. Since then the idea has been growing that chemical precipitation is the logical method to use in treating many types of industrial effluents.

From a survey of the literature, it would appear that lime has been used in some connection, although generally as a precipitating agent, in treating almost every kind of trade waste.

Uses Classified

The uses of lime in the treatment of these wastes, may be classified in general under the following heads:

(a) As a precipitating and coagulating agent.

(b) As a neutralizing agent for acid and similar wastes.

(c) As an agent to better the physical condition of sludge or to produce a sludge of fertilizing value.

(d) As an alkali to give the optimum pH for a given precipitant to act effectively, or for biological action to take place.

(e) As an electrolyte and chemical precipitant in the electrolytic treatment of sewage.

Lime as a Precipitating or Coagulating Agent

Lime came into extensive use as a precipitating and coagulating agent about the middle of the 19th century, in England.

Before that time sewages had been treated by plain sedimentation and filtering processes. As time went on, industrial progress and expansion produced sewages of great concentration and containing various trade wastes, so that plain sedimentation and filtration failed to give proper clarification and purification.

Chemical precipitation was now resorted to, on rather a large scale, for the treatment of these sewages, and this method has continued up to the present time.

The first precipitation agent used in this connection was lime, generally added in the form of milk of lime. The amount of lime used varied at different places with the character of the sewage; sewage containing a certain type of trade waste requiring somewhat dissimilar treatment from that of a sewage containing a different trade waste.

In general, experience showed that the best results were obtained by adding just enough lime to decompose the carbonates present and to neutralize the sewage. If too great a quantity was added, soluble organic salts were formed, causing a very putrescible and obnoxious effluent. If too small a quantity of lime was added, sedimentation took place at a very low rate.

Besides lime other chemicals were tried, but the best results were obtained with lime or a combination of lime and iron salts. This combination was found to remove most of the soluble organic matter as well as suspended solids, since a flocculent precipitatea of iron hydroxide is formed which is very efficient in carrying down suspended matter and coloring materials.

Full scale tests for the amount of lime required to produce certain results, has been the ideal way to determine the optimum proportions of lime or other chemicals to add to a given waste effluent. In actual practice in England the quantity of lime necessary when used alone

*Numerals in text refer to Bibliography at end of paper.

as a precipitant has been found to be about 15 grains per gallon of sewage treated. The amount of course varied with the quality of the sewage.

This lime precipitation process has also been in operation for a number of years in America, more particularly at Worcester, Mass., and Providence, Rhode Island. The sewage at both of these cities contain considerable quantities of trade wastes and the process has been very satisfactorily operated.

At Worcester, Mass., over 7,300 millions of gallons of sewage were treated by this process during the year 1920. The amount (3) of lime used varies between 6 and 10 grains per gallon. No iron is added, since the sewage is high in trade wastes containing iron.

The results of Hazen's (4) experiments on such sewage as that just mentioned indicate that between 80 per cent and 90 per cent of the suspended solids can be removed in a retention period of 6 to 8 hours when correct precipitation methods are employed and that a 97 to 98 per cent bacterial reduction results.

Other processes of this general character are Spencer alumino-ferric process (5) which consists in adding aluminum sulphate and iron salts, with or without lime, and the so-called ABC process in which lime, alum, clay and carbon are added to the sewage. These wastes that contain a good deal of colloidal matter.

From the results obtained, England, Worcester and Providence, it would seem that the popular prejudice against chemical precipitation methods if properly carried out, can be operated economically and efficiently.

Tannery Wastes

When we come to the treatment of such a typical trade waste as that produced by a tannery, we find according to Naylor (6) that in England, the various liquors from the tanning processes are precipitated with lime in a settling basin, after having been mixed, and are then run into aerobic filters. These waste liquors are made up of wash water from the preliminary washing process, lime dehairing waters, tanning pit liquors containing tannic and other acids, as well as pieces of skin and other putrescible matter, and are very obnoxious. The lime treatment assists in the deposition of the sludge and produces alkalinity conducive to the desired putrefaction on the filter. Here we see lime acting both as a precipitating agent and as an agent to give the alkalinity for the next step of the purification process.

In Massachusetts (7) the waste liquors from tanneries have been treated with slaked lime and then passed through sand filters. It is claimed that 60 to 70 per cent of the organic matter is removed by this treatment and the effluent is in a satisfactory condition to turn directly into the streams.

Woolen Mill Wastes

The waste liquors from woolen mills contain fats, soaps, saponifiable matter, free alcohols and waste scouring agents. These wastes are thus high in suspended solids and mineral matter as well as grease and fats.

A method has been in operation (8) where lime and iron salts are added to decompose the fats and soaps so they can be recovered. The resulting liquor is said to be free from suspended matter.

Acid suds effluent resulting from the grease recovery from suds by sulphuric acid, have also been very successfully treated wtih lime (8).

In Germany, a great deal of work has been done on the treatment of those woolen mill wastes with lime and colloidal clay (9). There seems to be a definite field for this latter process which has not yet been fully developed. It will be seen that lime is almost the sole precipitating agent for this type of trade waste.

Dye Wastes

When we come to the dye industry we find a kind of waste that is very difficult, in most cases, to treat. Dye wastes are usually high in suspended matter and contain dyes, acids and other obnoxious material. At one dye plant (10) the waste liquor containing starch, soap, gums, dyes and acids, is treated with lime and a lumino-ferric. About 4 grains of lime per gallon of sewage are used. The effluent is in an entirely satisfactory condition to discharge.

Brown has shown (11) from experiments on certain dye wastes, that when ferrous salts or alumina are used to treat the liquors, imperfect results are obobtained unless lime is added also. That is lime is the requisite agent to use in treating the wastes from the dyeing industry.

In another series of experiments on the effect of different chemicals on dye liquors of all colors (12), it has been demonstrated that the most efficient treatment was obtained by the use of lime and ferric chloride. These two agents gave excellent coagulation and removed

the coloring matter. Other precipitants did not do so well except in combination with lime.

Paper Mill Wastes

Liquors from paper works operating on the alkali processes are very polluting, even after the soda has been removed. The wash liquors and other wastes are first strained to remove fibers of pulp. They then contain clay, soaps, soda, etc. The treatment next given them is sedimentation with the aid of milk of lime (13). A very satisfactory way of treating these liquors also, especially if they are colored, is to add slaked (13) lime and ferric chloride. The flocculent precipitate of iron hydroxide drags down the coloring matter. The waste liquors from the sulphite process of paper manufacture, are usually high in organic matter and sulphur dioxide. The treatment consists generally, in a sedimentation process (14). Milk of lime is added and the liquors after settling, are cascaded over towers to remove the sulphur dioxide gas.

Wastes from strawboard plants, which are high in organic, colloidal and suspended matter, have been treated by adding lime, running the liquor through a settling basin and finally through screened cinder filters (15). This is a particularly difficult waste to treat since it contains a great deal of very putrescible matter. This matter of treatment has given quite satisfactory results. On the other hand the activated sludge process has not been successful with this type of waste.

Creamery and Dairy Wastes

Wherever a chemical precipitation process has been used in treating creamery and dairy wastes, lime has been almost exclusively the precipitating agent. Indeed, according to the German chemist Guth (15) "lime is the proper precipitant for all creamery waste products."

These creamery and dairy wastes are of three types, (a) fresh milk wastes, (b) buttermilk wastes, (c) wheys. In large creameries they are first treated wtih lime and then given a biological treatment. Lime and ferric chloride (17) have been found to be the best removers of the odors of milk wastes, which in the main are due to the decomposition of nitrogen compounds and to rancid fats. Most of the organic nitrogen can be removed by adding an excess of lime over that required to neutralize acidity and then passing the effluent over septic beds. The activated sludge and Imhoff tank processes have not proven satisfactory in general for this type of waste.

Canning Wastes

Wastes from the various canning processes have sprung into prominence of recent years. Many types and kinds of treatment have been tried but no method has proven entirely satisfactory from every standpoint. There seems to be an excellent possibility for the development of a lime treatment process in this field.

In New Jersey the wastes from tomato canning have recently been treated (18) with lime and ferrous sulphate. The bulletin of the Illinois State Water Survey for 1913 gives the treatment for pea and corn canning wastes as being lime precipitation- and neutralization, followed by sedimentation and filtering.

Starch Wastes

In the starch industry—that is, in the manufacture of starch products from corn —the steep water is in the main waste to be contended with along with cone and gluten water. These wastes are particularly heavy in total solids and besides are high in phosphates. The fact that the liquor is acid and that it contains nitrogenous matter, proteids and carbohydrates, gives fermentation an excellent opportunity to take place in a short time, and the liquor is thus difficult to treat both from the standpoint of time and chemistry.

Mechanical processes of treatment have failed utterly with such liquors (19) and chemical precipitation has been resorted to. Since these waters contain phosphates, lime may be added, forming a floc precipitate of calcium phosphate. It is thus unnecessary to add iron salts in order to get flocculent precipitating action. The lime is added in the form of a milk of lime. A clear non-offensive effluent is produced. At the Argo starch factory at Chicago, it has been found that 11.7 lbs. of lime are required per 1,000 gals. of waste to give the most efficient action.

These industries just given represent only a few of the many manufacturing processes which produce wastes that are or might be treated with lime as the precipitating agent.

The possibilities for lime in this connection seem to be limited only by our ability to apply and develop processes efficiently and economically. In particular there seems to be an undeveloped but fertile field in the treatment of canning, dairy, sugar, and paper mill wastes.

Lime as a Neutralizing Agent

One of the most obvious uses of lime is its neutralizing power. As a neutralizing

agent lime finds application in treating acid wastes from pickling iron and steel products in the steel industry. The ferrous sulphate formed by the pickling process is usually removed by appropriate methods and the spent acid liquor is then treated with lime. The lime not only neutralizes the spent acid but takes down the suspended iron salts as well (20).

Acid mine waters have become a source of pollution to many streams and are particularly detrimental to soil. They have been best treated with lime but there is need of accurate information on how to carry out the treatment effectively (21).

Acid wastes in the dye industry and paper industry have also been treated effectively with lime. The lime does especially well if iron is present since the floc precipitate of iron hydroxide is formed, which drags down suspended matter and absorbs colors.

In short, wherever an acid or similar waste is to be treated, lime appears to be the agent to use, both on account of its efficiency and its relatively low cost.

Use of Lime to Better the Physical Condition of Sludge or to Produce Alkalinity

Another application of lime is in the treatment of certain kinds of sludge in order to better their physical condition and thus make them easier to handle. The filterability of sludges from the various sewage treatment processes, such as activated sludge, Imhoff tanks, Miles acid and similar treatments, is a growing problem. The use of lime to improve filterability and physical condition of certain sludges has been tried in some cases. However, more research is needed along this line. The addition of lime to Miles acid sludge has given good results. The sludge before the addition of lime (22) is quite acid and dries very slowly, but after the lime treatment it filters well and dries rapidly.

In some cases sludges nitrify exceedingly slowly (23). Experiments on the addition of several substances such as silica gel and clay gave no improvement. The addition of calcium carbonate, however, gave marked improvement both in rate and completeness of nitrification, which indicates that alkalinity may be a determining factor. Experiments are in progress on the use of lime in this connection.

In Germany, Rohland has (24) developed a type of treatment called the Lime and Colloidal Clay process. Trade and other wastes are treated by adding lime and finely divided clay of the plastic variety. This combination in contact wtih water forms hydroxides of calcium, aluminum, iron and titanium which absorb coloring matter and settle out suspended material. The lime produces the desired alkalinity for the clay to act, and also is said to improve the physical condition of the sludge.

This process has been applied to the wastes from the dye, sugar, paper, tanning and soap industries. It is especially applicable to wastes containing coloring matter.

Lime as an Electrolyte and Precipitant in the Electrolytic Treatment of Sewage

Lime is now employed as an electrolyte and chemical precipitant in the treatment of sewage in the so-called "Direct Oxidation Process" and the "Selo Process." These processes are based on the passing of an electric current through sewage to which has been added lime. Nascent oxygen and hydrogen are liberated within the sewage. These readily attack organic matter and destroy it.

These electrolytic methods have been applied in some cases to specific trade wastes. At least one demonstration plant has given satisfactory results and at least two cities are installing the system for permanent use.

The Experimental Work at Ohio

Now just a word with regard to the work being carried out along this line at Ohio State University.

Van der Meulen and Smith have shown that alum, when added to ripe Imhoff sludge, increases the speed of filtering and lowers the moisture content of the filter cake obtained, as well as giving a relatively heavier cake. We have tried the effect on filterability of such a sludge of adding increasing amounts of lime. While lime does not give much of an increase in the weight of the filter cake, it does increase the speed of filtering.

Van der Meulen found that upon adding 12cc. of a normal alum solution to 100 cc. of sludge and filtering under reduced pressure, all visible moisture disappeared in 2 to 3 minutes. We have found that 10 cc. of milk of lime suspension containing 18.5 g. of calcium hydroxide per liter when added to 80 cc. of sludge and diluted to one liter, gave a sludge of no visible moisture in about 4 to 6 minutes. These results are not quite a fair comparison since the conditions of our experiments were not exactly equivalent to his. However, at the present time we are

running experiments under similar conditions.

The addition of ferrous sulphate along with lime gives a quite porous filter cake which filters just as readily as an alum treated sludge. 30 cc. of the above milk of lime solution in conjunction with 5 cc. of a ferrous sulphate solution containing 200 g. per liter, produces a cake which is free from visible moisture in 1 minute.

We are also experimenting on the addition of lime to dairy and creamery wastes, and the results while not in any sense conclusive, indicate that lime precipitation methods are efficient in the treatment of such wastes.

As has been remarked, the liquor wastes from the canning industry represent a fertile field for the development of chemical precipitation methods of treatment, on account of the seasonability of the industry and the cost of installing certain types of disposal works. We intend to go into the treatment of such wastes at an early date. We are also investigating the efficiency of various chemicals on other wastes such as straw board waste, which is particularly difficult to treat.

Along the line of sludge handling, we are going on with the work on the effect of lime on the filterability and digestibility of different types of sludge such as Imhoff, Miles acid and septic tank. We also want to take up the effect of lime on the nitrification of such sludges.

What we are aiming for, of course, is the development of processes and the collection of data methods of treating different trade wastes with lime as well as the use of lime in special applications such as sludge handling.

Conclusion

These remarks do not, of course, exhaust the uses or the possibilities for use of lime in the treatment of trade wastes, either as a precipitating agent or in some other connection. There appears to be a very definite and quite extensive field for lime in the treatment of these manufacturing wastes. Wherever a neutralizing or precipitating agent is needed, lime is almost instinctively turned to as the logical substance to use.

Right at present there is a whole field of research open on this subject.

(1) Data is needed on the relative efficiency of lime and lime processes in comparison with other precipitants and processes.

(2) Economical and efficient processes are required for the treatment of the wastes of certain industries.

(3) The problems of sludge handling and sludge dewatering are in most cases bound up with hydrogen-ion concentrations and the use of lime in this connection needs to be studied.

And finally, the whole trade waste situation needs to be studied from the standpoint of lime and lime processes, and these processes developed and got together in such form that they are attractive to both the engineer and manufacturer.

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The foregoing paper by Mr. Ferguson presented before the 1924 meeting of the National Lime Association.

SANITATION AND THE UNTAMED SUMMER RESORT COTTAGER

(Editor's Note: The summer resort "cottager" is a menace to himself and his neighbors so far as sanitation is concerned. What follows is from a paper by John M. Hepler, assistant engineer, Michigan Department of Health, Lansing, before the recent annual meeting of the American Public Health Association, on "Sanitation Problems in Resorts and

Tourist Camps." Only the portion of the paper relating to the private cottage owner is reproduced here.)

The private cottage owner presents a condition which we have so far been unable to handle to our satisfaction. We have here a group friendly with one another for social purposes only. The individual's own back yard is the limit of his worries; yet he is ready to complain at the first smell or annoyance his neighbor creates. The cottage is a luxury used but a month or two in a year, and, as such, usually receives the minimum of expenditures upon it. If ordered to improve sanitary conditions, the owner invariably wants to know why Smith or Brown doesn't have to do the same thing. Community pride is too often lacking and when considered as a resort there is no one to enforce orders or cause even the abatement of minor nuisances.

Generally, these resorts are not located within corporate limits and the township health officer is expected to see that nuisance and unhealthful conditions do not exist. This person is usually a tradesman or farmer busy with his own affairs and unversed in sanitary procedure who can hardly be expected to devote time enough to this work to insure efficient results. Very frequently his policy of action is dictated by the business men serving the resort. In other words the resorter's open pocketbook is more to be considered than health. .

When the resort is within corporate limits the local health officer is often too busy with his private practice to pay much attention to the resort, or for the same pecuniary reasons that the township health officer has, he fails to act.

The state representative, therefore, has the work to do and that requires time and effort for he must work with each individual owner. To overcome this it was decided that resort associations would help materially. If the resort could be organized so that a few would speak for all, and what the few decided was necessary for the resort and ordered by them would be performed by all, our work would be greatly simplified.

Experience has shown that this is not always the satisfactory solution. At one resort most of the cottage owners formed such an association and since then every nuisance has been simply the expression of petty meanness, kicking against the few who for one reason or another did not join, rather than trying to improve conditions. In the main, however, resort associations have assisted materially in relieving the constituted authorities of much detail work.

The sanitation problems of this group are, therefore, all the problems of sanitation. Whater is usually obtained from shallow driven or dug wells which are invariably placed close to the kitchen door. Garbage is usually buried within a few feet of the well and the privy is on the back of the lot. As a rule lake resort lots are small, and locating the cottage, well, garbage pit and privy within the lines of the owner's lot causes a close setting which establishes a potential danger at the very beginning.

The inspector at such a resort can do nothing more than visit every cottage, take a sample of their well water, and inspect the premises. If any corrections are necessary, the individual must receive the order and follow-up work must be done by the same department to see that orders are carried out. This is slow work and few resorts can be handled during the resort season without an unreasonable number of inspectors. The solution seems to be the provision by the state for full-time district or county health officers and in the larger resorts, sanitary inspectors for the individual cases.

Another phase of this work which is encountered during the last two weeks of August is the desire of the cottager to evade the order to improve by shortening his stay a week or two, honing, no doubt, that by the next season the nuisance will have disappeared. Frequently when an inspector has visited the resort and ordered the correction of insanitary conditions or the elimination of a nuisance, a return visit will reveal the fact that the day or two after the inspector's visit the tenant has packed up and gone home. Education along health requirements and the common need of decency to the neighbor seem to be the biggest need in this group when centralized government, as an association, is lacking. Careful inspection and follow-up work are essential.

SOME INDIANA HIGHWAY MAINTENANCE METHODS

By A. H. Hinkle, Superintendent of Maintenance, Indiana State Highway Commission, State House, Indianapolis, Ind.

When Indiana took over some 3,000 miles of roads about five years ago, most of this mileage was worn out gravel

roads, 10 to 12 ft. wide, many of which had little or no ditch alongside.

The first requirement was to throw up a road shoulder with a big grader, leaving a proper width between the shoulders for the width of gravel with which the road was to be resurfaced. We find nothing better for this work than a 10-ton "caterpillar" tractor, drawing a 12-ft. blade grader. We use Holt "caterpillar" tractors.

Where only short cuts are required, earth can be moved longitudinally down the slope by setting blade at right angles to the line of travel. This permits use of the machine to remove earth short distances down the road as well as to move it over toward center of the road. With only small amounts of grading necessary one tractor outfit will grade a mile of road a week.

We find that a good grader man with this outfit will do two to four times as much work as one who can't acquire the knack of using machinery. With large amounts of earth to move longitudinally, we use slip graders for the short hauls, and wheel scrapers for the longer hauls. One good tractor operator and one strong man to operate the grader are necessary.

Gravel should be put on over old surface to a width of 18 ft., or such width as desired. Eighteen or 20 ft. make a suitable width for two-way traffic at high speed. Gravel should be spread in layers not exceeding 3 or 4 ins. at a time, then a second layer, but not until the first layer has compacted under traffic. If a compact surface is wished immediately it will be necessary to sprinkle and roll the new gravel, or roll it after it has been dampened by rain. Without rolling the thin layers of gravel will soon compact under traffic, and this can be accelerated by harrowing with an ordinary farm harrow. The compacting process will be quicker with clay added to the gravel. However, the more clay mixed with the gravel the less resistant the gravel surface becomes to cutting under traffic. It is therefore more desirable to use a clean grade of gravel. Excess clay will cause new gravel to compact quickly, but it will cut up and become sloppy after continued rains.

Our specifications used for gravel for the top 3 ins. of surface road are: All gravel shall pass a 1¼-in. circular opening and not over 40 per cent shall pass through ¼-in. opening, nor more than 15 per cent through a No. 10 sieve, or 8 per cent through a No. 30 sieve.

When a second layer is added the shoulders should be thrown up sufficiently high to keep the gravel from being knocked off into the ditches. Large gravels may be used for building a foundation, but if near or on the surface, cause unsatisfactory roads.

It is important to build the road surface so it will have a crown of about 4 ins. in an 18-ft. road. After gravel is placed it is smoothed with a small grader pulled by a tractor or truck. This is essential, for if gravel is dumped in piles and permitted to partly compact before being uniformly spread, it is certain to produce bumps in the road in later years. These are difficult to remove without scarifying and entirely reshaping the road.

We haul practically all our gravel in trucks, spreading it from the rear end of the truck as it is dumped. A 3½-ton truck will haul on an average of 70-yd. miles per day. Ordinarily in one gang there should be no more trucks than sufficent to haul 500 yds. per day, as otherwise trucks will interfere with each other in dumping.

The secret of our good gravel roads is proper maintenance methods after they have been resurfaced. We apply thin layers of gravel several times a year using 200 to 500 yds. per mile per year. The great problem is to get the men started to spreading the gravel thin enough. After proper application of gravel, dragging is next important. It is desirable to scrape and drag the surface with a long base drag, road grader, or maintainer frequently enough to keep the surface continually smooth. In our state where traffic is heavier in some parts than others, some roads are dragged only once a week, and others each day. This is determined by weather conditions and volume of traffic. We drag with a truck pulling a light 7-ft. blade grader, or a long base drag. We use Nash Quads of 4-wheel drive trucks for dragging, because this equipment was received from the government. However, if we were to buy new equipment I am quite sure that the Fordson tractor, or perhaps a slightly heavier tractor would be most economical for dragging. The Fordson would not, of course, pull the heavy drags in the heavy coat of loose gravel, but these drags are not intended for dragging the surface after it has become hard and compacted.

After the road is under normal maintenance there should be kept upon the

surface a thin coat of loose gravel, so thin it does not interfere with traffic but sufficient to fill little depressions when dragging. We have a patrolman, with a truck, for every 8 to 20 miles to drag road surfaces.

AIR LIFT PUMPING PLANT AT DUBUQUE, IOWA

By J. W. McEvoy, Superintendent City Water Works, Dubuque, Iowa

Early in 1922 it became apparent to the city officials of Dubuque that steps must be taken to increase the capacity of the water works pumping station. The engineering firm of Mead & Seastone of Madison, Wis., was engaged and requested to make a survey and report with recommendations as to the necessary changes and additions.

Two Sources of Supply

At this time the water works consisted of two sources of supply: (1) A group of shallow sand wells averaging 6 or 12 ins. in diameter and about 100 ft. in depth were all connected to the suction of a steam driven pump and the water was discharged into a surface reservoir of 500,000 gals. capacity. The suction of this pump was also connected to a large sand well of 8-ft. diameter. The daily capacity of this system was 1,570,000 gals.

(2) The second source of supply was from four artesian wells averaging from 1,300 to 1,450 ft. in depth. These wells had a natural flow of 1,016,712 gals. and were also arranged so that they could be pumped by suction from a motor driven centrifugal pump. When pumped in this manner the total delivery was 1,779,840 gnd. This gives a total pumpage from the complete system of 3,349,840 gpd. A high duty steam pump was used to take the water from the surface reservoir to a large 7½ million gal. reservoir located on a bluff at a point higher than most of the service demand. A stand pipe is located at a still higher point to serve the part of the population above the large reservoir.

Source of Additional Supply

In determining upon the source of water which should be used for the new plant, there were three different sources to be considered. (1) The Mississippi River (with filtration); (2) The shallow sand wells; (3) The deep artesian wells about 1,500 ft. deep into St. Peter and Potsdam sandstone.

Serious consideration was given to a filtered supply from the Mississippi River due to the fact that this source would provide ample supply for all time. The cost of a plant to develop this river supply would be much greater in initial investment, cost of operation and maintenance than that for a ground water supply.

The second source of supply and the one from which a large part of the water is now obtained is from the sand stratum located at a depth of about 100 ft. below the surface. The extent of this stratum is somewhat limited which necessitates the placing of the wells fairly close together. Tests conducted over a period of years has shown that the amount of water pumped from the sand wells is constantly decreasing. The most serious problem encountered in developing a supply from this source is that of mutual interference of the wells. Tests showed that when pumping all the wells at one time the total yield was only 78.8 per cent of the sum of the individual capacities. It is a well-known fact that the lower the water level is dropped in a well, the greater becomes the circle of influence towards interference. The lowering of this water level to the top of the water bearing stratum which would be necessary in order to obtain a sufficient supply, would cause considerable interference with any other well which might be put down in this sand. This question of interference makes the development and securing of ample supply from this source from large wells, a very doubtful problem. The static level of the water in this sand stratum is 15 ft. below the surface while the bottom of the sand layer is 100 ft. so that the available drawdown is 85 ft. With the large diameter open type well it would be practically impossible to lower the water closer than 20 ft. from the bottom of the well. Tests conducted showed that the maximum quantity which could be obtained with this drawdown would be about 4,970,000 gals. per day from this shallow sand layer. Due to the matter of interference, the limited extent of the sand stratum and the lack of definite information as to the amount of water available from this source, the idea of developing this supply was also abandoned.

Artesian Wells

Artesian wells have been in use in the city of Dubuque for many years and have always been a very constant and reliable source of supply. When the first wells were drilled the static level was about

100 ft. above the ground surface. The static level of the artesian wells at the water works is now 23 ft. above the surface of the ground. It is a well established fact that there is a considerable drop in static head on an artesian basin when wells are first drilled. A portion of the static head is consumed in creating the flow for the new wells and this decrease continues in a certain locality as long as new wells are drilled. As the number of wells increases the lowering of the static head decreases so that at the present time with a large number of wells in operation, the drilling of a new well has very little effect on the wells already in operation. The loss in head of a well which becomes evident with age is due to: (1) developments of defects in the well casing; (2) gradual filling up of the pores of the sandstone due to the drifting of fine material to the well; (3) growth of low forms of plant life in the pores of the rock. The losses may be corrected by replacing the defective casing and by pumping into the well and reversing the flow or reaming the well, or shooting with dynamite at the water strata. Tests have proved that the falling off in capacity of artesian wells is very slight providing the wells are maintained properly.

The four artesian wells which were already in use at the plant were tested and it was found that the yield was 28.7 gals. per minute per ft. of drawdown. Practice has demonstrated time and again that when the total drawdown of an artesian well is about 10 per cent of the depth of the well, the increase in capacity is proportional to the drawdown. Hence, by lowering the water level to a depth of 100 ft. below the ground surface a total capacity of 5,100,000 gpd. or as much more as could be obtained from the strata could be pumped. It was deemed advisable to figure on one additional well in order to give a total capacity of over 6,000,000 gpd. from the artesian well system.

Developing the Artesian Supply

The initial cost of a plant to develop either the shallow or the artesian well supply would be practically equal while the cost of operation and maintenance would be lower with the artesian well system. The artesian system would have a capacity of over 1,000,000 gpd. in excess of the shallow wells. The supply from the artesian wells is a known quantity while it is very uncertain as to how much water could really be obtained from the shallow sand strata. Due to the above reasons it was decided to develop the artesian supply as a permanent source of water. It then remained to adopt a method of pumping which would prove most economical over a period of years and yet be reliable and satisfactory.

The Air Lift Chosen

In pumping water from deep wells it is recognized that any method of pumping is bound to be relatively inefficient. Either one of two systems were available. (1) the air lift method; (2) motor driven deep well turbines. Careful comparisons of these two methods were made in order to choose the one which seemed most advisable. It is a well-known fact that the actual pumping efficiency of the deep well turbine is slightly better than that of the air lift system but it was found that by the use of the proper machinery the total cost of raising water by means of the air lift was shown to be less than with deep well pumps, taking the overall efficiency from wire to water and making due allowances for maintenance and repair expenses. The simplicity and reliability of the air lift, particularly the freedom from moving parts below the ground, requiring oiling and subject to wear, make it a more satisfactory method of pumping than centrifugal deep well pumps with high speed runners and long shafts located at inaccessible places deep in the wells. With the air lift system all the moving parts are located in the power house where they can be under constant inspection.

Advantages of Air Lift

The advantages of the air lift system over the deep well pump are summed up as follows: (1) The air lift is dependable, simple and durable and will deliver water year in and year out with small chance of interruption of service by breakdown of the plant; (2) modern air lift practice secures very high pumping efficiency and this efficiency is maintained for long periods of time. With the deep well turbine due to wear the efficiency is highest at the start and is continually decreasing; (3) more water can be obtained from a given well by the air lift than with any other method. With air the wells can be back-blowed and cleaned in this way keeping them up to their original capacity and even increasing the first delivery due to opening up the pores in the sandstone; (4) the air lift is more flexible. Water may be pumped at widely varying rates without materially low-

ering the efficiency. A change in pumping level will not change the efficiency. A group of wells may be operated from a central point, which means minimum attention to the machinery.

The main objections to the use of the deep well turbine are: (1) the rapid moving parts which are located in the well require constant replacing which is a costly operation; (2) sand causes rapid wearing of parts while it has no effect on the air lift; (3) the deep well turbine cannot efficiently follow the water to a lower level and will not pump efficiently at varying capacities. After comparting the two systems and for the above given reasons it was decided by the engineers to adopt the air lift system for pumping the artesian wells.

Low Power Rate

Due to the very favorable outlay of the whole system at Dubuque, the city was able to obtain a very low power rate in view of the fact that all the pumping, except in emergencies, would be done in the offpeak periods for the local power company, or from early evening until late morning. The average daily consumption of water is about 3,000,000 gals. and due to the elevations in the city it was possible to have a high duty reservoir of 7,500,000 gals. capacity which supplies the largest part of the demand. Because of this low power rate it was by far the most economical to install electrically operated equipment.

The Air Lift Equipment

A new addition to the present water works was made and in it was housed the air compressors and centrifugal service pump. The contract for installing the air lift system was let to the Sullivan Machinery Co., of Chicago. The compressor plant consists of two units of the Sullivan class WJ-4 size 20x12x14-in. belt driven compressors each having a capacity of 2,428 cu. ft. per minute. These machines are operated by 400-hp. synchronous motors. The compressors discharge into a large air receiver and from this are the distribution pipes leading to the five wells. Each well is equipped with a Sullivan central type 8x2½-in. air lift footpiece with a Sullivan Cyclone Booster. The boosters are placed in concrete pits which are entirely below the ground surface. They are used to elevate the water to the surface reservoir which is at a higher elevation than the well tops. The discharge from all five wells goes over a permanent wier before it enters the reservoir. A large motor driven, direct connected centrifugal pump is used at this plant to force the water into the high duty reservoir.

Guaranteed Performance

All machinery was installed on a performance guarantee basis and early in September the test of the air lift system was made by the engineers. The results of this test showed a total pumpage of 6,475,680 gals. per day pumped with an average total lift of 128 ft. Under these conditions the guaranteed air consumption was 0,940 cu. ft. per gallon of water and the test showed an actual consumption of only 0.442 cu. ft. or the air consumed was 11 per cent less than the guarantee. The total horsepower required was 412 while the guarantee was 428 hp.

In addition to the improvements at the main pumping station a small booster station is being constructed near the same elevation as the high duty reservoir. Two motor driven centrifugal pumps, automatically controlled are used to pump the water to the standpipe which supplies the very highest portions of the city.

With the completion of these improvements the city of Dubuque now has a total pumping capacity of about 6½ million gallons per day from the artesian system and in addition has a supply of 1½ million gallons from the shallow sand wells, thus making a total capacity of about 8 million gallons per day with a daily consumption averaging about 3 million gallons. With the two-day supply high duty reservoir,- adequate service mains and a most reliable pumping equipment the city of Dubuque can be fairly well assured of a reliable and constant supply of water for some years to come.

The foregoing paper by Mr. McEvoy was presented at the recent annual meeting of the Iowa section of the American Water Works Associtaion.

USE OF OIL ENGINES BY PERRY, IOWA, WATER WORKS

By J. B. Trenchard, Fairbanks, Morse & Co., 213 W. Court St., Des Moines, Iowa

As evidence of what is being accomplished, or being realized, by municipalities who have investigated, purchased and installed oil engines for pumping their water supply I desire to submit a report taken from the records, setting forth the conditions existing at Perry, Iowa.

The city of Perry has 4 deep wells which are equipped with deep well pumps

operated by electric motors, which pump the water from the deep wells into the surface reservoir located at the plant. Prior to installing oil engine equipment last Spring, they were using a large flywheel type steam pump, pumping the water from the surface reservoir into the distribution system, against direct pressure.

Also prior to making the installation of oil engines and generators last January they were purchasing electric current from a Utility Company, for operating the motors on the deep wells and a sewer lift pump located in the plant.

For a twelve month period previous to making the installation of the new equipment, their fuel cost for operating the steam-driven pump and their electric current for operating the deep well and sewer pumps were as follows:

Elec. current @ 2¼c per K.W.	$5,859.20
Coal and wood	6,653.02
Total	$11,512.22

During that period they pumped 213,214,000 gal. of water. Therefore their cost for electric current, coal and wood was 5.39c per 1,000 gal.

After completing the installation of the new equipment and instituting a system of keeping accurate records, during six months their cost and results have been as follows:

Month	K.W.H. Generated	Fuel Oil used @ 45¼c per gal.	Gal. Water Pumped
April	31,071	3,181	18,460,000
May	35,030	3,555	18,050,000
June	36,610	3,686	19,054,000
July	37,770	3,963	18,917,000
Aug.	38,920	4,017	18,958,000
Sept.	39,880	4,175	19,706,000
	219,281	22,577	113,145,000

The above records show that they are generating 9.71 K.W.H. per gallon of fuel oil consumed and at the present price would be equivalent to 0.54c per K.W.H. and is also equivalent to a cost of 1c per 1,000 gals. which will net a saving of something over $825 per month.

During the period of the six months referred to above they pumped 113,145,000 gals. of water at a fuel cost of 1c per 1,000 gals. and when compared with their former cost of 5.39c per 1,000 gals. with their former equipment it shows a saving of 4.39c per 1,000 gals., times 113,145,000 gals. for six months shows a saving of $4,967.06; or this will equal per year approximately $9,934.12.

At this rate the savings in three years will amount to considerably more than the cost price of the equipment.

Their new plant consists of two 100 HP. Type "Y" Fuel Oil Engines, direct connected to dynamos and three centrifugal pumps direct connected to electric motors. The three centrifugal pumps take the place of their former large fly wheel type steam pump, pumping from the reservoir into the distribution system and having a variation in capacity of from 400 to 1,200 gals. per minute, the engines and generators furnishing electric current for operating the deep well pumps, the centrifugal pumps, and the sewer lift pump and all lights that are used in their building.

Every pumping job is an individual engineering problem, as it's rarely, if ever, there are two exactly alike. In order to realize the highest degree of efficiency it is advisable to direct connect the motive power with the pump; this eliminates any loss between the two.

Many cases are similar to the one at Perry, Iowa, where they have several deep wells from which the water is pumped into a surface reservoir and from the surface reservoir into the distribution system, against what is termed direct pressure. In such cases as this it requires several pumps not only for the deep wells, but also boosters on the distribution system, in order to furnish the required amount of water for regular consumption and an adequate amount at the time of a fire. In such cases as this it is advisable to put in direct connected motors and centrifugal pumps and by specifying oil engines direct connected to generators, when operating at capacity, current can be furnished equivalent to 1c per K.W.H.

The foregoing matter is from a paper by Mr. Trenchard before the 1924 meeting of the Iowa Section of the American Water Works Association.

PAVEMENT RESURFACING AND RECONSTRUCTION AT ALTOONA, PA.

By H. J. Baum, City Engineer, Altoona, Pa.

The paving resurface and reconstruction problem is pressing for solution in Altoona, and as we are one of about seventy cities of a population ranging from 50,000 to 100,000, our experience may be quite similar to that of other cities in its class.

The stage of the resurfacing problem varies somewhat with the age of the various cities, but the movement to pave streets has been on the increase, keeping

pace wits the improvement of the standards of living and the necessity for having hard, clean streets on which to live and smooth durable pavements on which to travel.

The first of our permanent paving was commenced about 35 years ago when a limited yardage of brick and asphalt block was laid, but it was not until 1907 that a real paving program was laid out and followed.

In the ten year period, 1907-1917 inclusive, 73,000 sq. yds. per year were built; then a period of comparative inactivity during the war and the era of labor scarcity and high prices which followed, and it was not until 1922 that the forward movement got under way topping all previous records for completion of new paving.

With our 65 miles of paved streets and alleys, which represent 41 per cent of our entire mileage, we find that in the 35 years since our first streets were paved, about 12 per cent of our pavements have been replaced and though some of the earliest pavements are in use today we have replaced other pavements as high as three times and now, what is of most concern to us, is the present necessity for the replacement of a large mileage which is in such condition that further use is not only uncomfortable to the motorist but uneconomical in upkeep.

Reasons for Replacement

The reasons for replacement are not far to seek, and it is possible that most cities recognize some if not all of the following causes:

(1) The wearing out of the surface—base still adequate.

(2) Poor drainage; causing rapid destruction of base due to low bearing values of subsoil, further accelerated by excessive frost action.

(3) Transverse and longitudinal cuts in pavement, trenches poorly back filled, the consequent settlement, causing progressive failure of the base.

(4) Little or no maintenance, or the kind that is always fixing up the worst holes.

(5) Heavy overloads—No restriction on the overloaded truck, the streets on which it may travel or its speed.

(6) Change in the traffic use of a street—built for suburban or light traffic and later converted into a through route with heavy traffic.

(7) Defective specifications and inefficient inspection.

Salvage Value of Old Pavements

In reviewing the causes for reconstruction there is no fault to be found with the pavement that wears out—it has achieved its purpose, often at low cost. Whether it is proper to build a pavement, use it and then throw it away to make place for another new pavement is a question of first importance not only to the designers but for the public which pays. The salvage value of a pavement, which is too rough in its present condition and too expensive to maintain, depends upon a number of factors which determine whether resurfacing is possible or practical.

In road construction outside of the City, the highway builder can nearly always utilize a road bed which has been brought to grade as a foundation on which to place a permanent top, or after a permanent paving has been laid another can be built upon it. In the City the drainage problem and the presence of street car tracks, or other permanent structures, will definitely limit the resurface and reconstruction problem.

If drainage has been the cause of the failure, it seems unnecessary to say that this condition be corrected before either resurfacing or reconstruction be considered.

Forestalling Pavement Cuts

While there is no way of telling when a pavement cut will be made to take care of repairs to substructures, there is a possibility of foreseeing the expected use of property within reasonable limits, and providing for the building of such service lines as gas, water, sewer, etc., as are needed to properly develop abutting property.—This is being done in our city. —After some harrowing experiences in cutting up new pavements these utilities are now provided before instead of after.

In this respect Altoona is perhaps more fortunate than many of her sister cities, for about 75 per cent of the four square miles of our City's area is now occupied and the remainder, especially where pavements are constructed, are being quickly built up. In our present program of repaving we are paying close attention to the need of new service pipes and the repair of old ones, seeing that the work is done after giving proper notice.

Truck Loading

To mention heavy trucking as one of the causes of failure and not to provide for it in reconstruction plans is to continue the repaving process in short and

endless cycles. To legislate against it and enforce a reasonable use of the paving will permit much of what is built to be used a reasonable length of time before destruction, but if economic transportation depends upon the larger truck then it is time to consider building pavements, especially on our through routes that will stand up under its use. In Altoona, with no load limitations, it is necessary to replace old pavements with stronger ones to carry this type of traffic especially on the through traffic routes where streets are narrow.

New Surfacing

Where the base affords ample support to carry a new surface on highways having no street car tracks, we either remove the wearing surface and replace it with another or in the case of the rigid types,—brick, stone block, etc.—we place a new wearing surface upon the old. The resurfacing material used last year, an admixture to Portland cement concrete, laid to a depth of 3 ins. at the curb and 4 ins. in the center of the street, has provided a smooth surface and while the gutters were decreased to a depth of 2 or 3 ins., no trouble has been experienced in carrying off the surface water. There are streets, however, where the depth at the curb can not be altered and there either the old surface needs to be adjusted to a lower elevation, or the old surfacing material must be entirely removed to make room for the new surface.

Deep Gutters

The necessity for providing ample drainage involves the problem of finding a surfacing material which, though thin, will stand up under the traffic to which it is subjected. A number of bituminous pavements meet that condition, but it seems to me that the designer of rigid pavements can greatly increase their salvage value by providing gutters 7 to 7½ ins. deep. This would allow a thicker topping surface to be placed upon the old pavement, thus utilizing the maximum salvage value of solid road bed and permitting a wider range of resurfacing materials.

Along street car tracks in the business district, our narrow paving makes the adjustment of pavement impracticable excepting in one instance where a Ligonier block pavement may be adjusted along the rails which will allow a 2-in. topping surface to be used. In general, along street car tracks, we find it necessary to remove the old paving surface and usually the base. Past efforts to lay a new top on the old 6 in. base on heavy traffic streets has resulted in the early failure of the resurfaced pavement.

Separating Car Track from Pavement

Our pavement reconstruction program has taken into consideration the heavier traffic requirements on the through traffic streets where an 8-in. base of 1-3-6 mix is used together with a header block 1 ft. outside of the rail. With brick and wood block pavements we use a 3x12x12-in. creosoted wood header block laid on 8-in. base, a trench about 10 ins. wide being dug to the bottom of the track structure allowing a minimum of 8 ins. of concrete below the header block. This reinforcement of the edge of our pavement is necessary to prevent progressive destruction from the foot wide strip of the Street Railway Company, which has a tendency to go down and ours would go with it except for the header block construction which completely separates the vibrating rail structure from our pavement. For our concrete pavements, along street car tracks, we are planning on using a steel guard along the edge nearest the rail to protect it from rapid wear.

The fact that so many of the pavements along car tracks needed rebuilding has resulted in the complete separation of pavements, with a definitely divided and reinforced edge, which is giving excellent results, not only in the perfect condition of such pavements, but in the improved condition of the traction company's pavement which is more carefully maintained in order to keep it flush with the header block.

Car Track Paving

The Street Railway Company builds and maintains the pavement between rails and one foot outside, repairing or rebuilding their track structure in advance of street paving operations. They use three standard methods of construction which I will give in the order of their general use.

First—Stone ballast base about 8 in. in thickness, tamped solidly under the tie, 6 in. concrete between ties and stone grit cushion under grouted brick top. Second—6 in. concrete base, 2 in. stone ballast under wooden ties, and balance of construction as above mentioned. Third—Steel tie, embedded in 7 in. concrete, rail securely bolted to plates which in turn are fastened to pairs of channels laid transversely to rail, cushion and brick as above. While the last two methods give the best results, the time

during which a street may be used for track renewals in our congested district often limits the construction to the first named method. This type of construction is not rigid and trouble results from track settlement and from pumping of the track in the more unstable areas. Better results can be obtained by the more general use of the rigid type of construction.

Some Mistakes

Upon the design and specifications for pavements rests much of the responsibility for early resurfacing or reconstruction. I will mention some which our City has experienced and isn't in any immediate danger of duplicating:

A 1-3-8 base for brick pavements—breaking up, especially where the subgrade is somewhat unstable. We are now using 1-3-6 mix with recommendation for 1-2½-5.

Sand cushion under brick on steep sills—Sand washing out permitted settlement with bad longitudinal cracks—now using granulated slag or sand cement.

Wood block with 12 in. distillate oil treatment and laid up too tight—failure due to swelling of block and lifting up from base—now corrected by using a lug block treated with heavier Creosote oil or plain block with spreaders laid on thin pitch cushion.

Concrete pavement of small yardage laid with stone grit (without sand) for fine aggregate. Fine aggregate matrix, testing in tensile strength up to 150 per cent above our local sands does not stand the shock of traffic, pitting deeply to the point of becoming abnormally rough over limited areas.

It isn't pleasant to talk about our shortcomings, but they have been offered to show the necessity of careful writing of specifications, careful selection of materials and constant and efficient supervision, as they all bear upon the resurfacing and reconstruction problem.

Backfilling Trenches

By greater attention to the refilling of trenches, thereby securing on equal bearing for the foundation over those areas, an impossibility without a well managed plan of handling such backfills, one of the incipient causes of paving failures can be removed. This is a problem that too many of our cities are side-stepping instead of taking it in hand and meeting it squarely and effectively. The heavy trucks today are finding these weak places with disconcerting regularity which is worrying the highway maintenance crews and bringing the day of reconstruction nearer.

Basically the resurface problem is feasible and economical only if the foundation is adequate and, upon the failure to recognize this fact, great sums of money can be wasted in the temporary relief given by new surfaces which soon fail in complete sympathy with the base. With base adequate, the exposure needed at the curb will limit the thickness of the resurfacing cover, a greater thickness permitting a greater choice in type of resurfacing material—a 7 or ½ in. initial exposure of curb on new paving is offered as the designer's contribution toward solving the resurface problem.

Reconstruction of pavements takes cognizance of the reasons for failure. A subgrade well prepared and drained, a base sufficient to carry the present traffic with reasonable provision for carrying expected future traffic, both with respect to kind and volume, and a top which will give the expected service is an individual problem for each location. Our cities can possibly simplify their problem by adopting certain standards of pavement for business and residential sections and reduce the kinds of pavements to a minimum, thereby eliminating the necessity for such a diversity of repair stocks of materials and simplifying the maintenance and repair problem.

Financing

The question of financing the resurfacing and reconstruction problem is a matter in which engineers are interested. Should paving resurface and reconstruction be financed from current revenues or by bond issue? I have in mind a small city which paved almost all its streets some twenty years ago and then used them these twenty years without further building until the present when more pavements are to be built and old ones resurfaced.

If all cities paved in about the same manner, the bond issue method of repaving would seem feasible, but the history of paving is one of continued activity in most cities, and while our sudden increase in traffic has hastened the day of reconstruction for much of the lighter pavements, each year seems to have its share of streets that should be resurfaced or repaved. In principle it appears to me that financing should be done from current revenues, for if the cities can not stand the direct charge for reconstruction, the day will most surely be close at hand when annual reconstruction costs

and interest charges will become intolerable. Perhaps other cities, as well as our own, are looking toward a bond issue as the quick solution of deferred reconstruction, which will give us a chance to catch up with the reconstruction work, but as a matter of continued policy it does not seem advisable.

To summarize: Paving resurface and reconstruction involves a more careful policy in the making and replacing of pavement cuts to insure an unyielding sub-base, and the placing of service pipes up to the reasonable expectation of use of property; the regulation of truck traffic as a factor of reconstruction, and the building of pavements to carry the present and expected future traffic; the building of better track structures and the separation of vibrating track structures from rigid pavement surfaces. The design of curb exposure which will permit a resurfacing operation without undue encroachment upon drainage capacity; and the educational work in bringing the general public to see that public funds should be available from current revenues to resurface and replace pavements when and as needed. While there are certain phases in the paving resurface and reconstruction problems that are purely local in character, there are other underlying conditions in each city which are similar and which require careful planning in the construction of new pavements and in the reconstruction of old ones.

The foregoing paper by Mr. Baum was presented before the Engineers Club of Philadelphia in February, 1924.

INCREASING PAVING BRICK ASSOCIATION SERVICE IN ILLINOIS

Due to a steadily expanding business the Illinois Paving Brick Manufacturers' Association, representing the paving brick industry of that State, has just taken steps to extend its personal service to public engineers and other officials by engaging John M. Egan, Jr., C. E., of Aurora, Ill., as chief engineer.

Thoroughly trained by years of experience along engineering and contracting lines, and particularly well informed in the paving brick end of the clay products industry Mr. Egan will co-operate in a consulting capacity with engineers, other public officials and the public in general in order to promote the proper design and construction of brick pavements as dictated by the most modern developments.

Educated at the Boston Institute of Technology Mr. Egan spent several years in the South on railway engineering. For the last 17 years he has been engaged in engineering and contracting on drainage, sewerage and paving construction in and around Chicago. He is a member of the Wisconsin Engineering Society, the Illinois Society of Engineers and the Western Society of Engineers.

The Illinois Association headquarters are located at Springfield, Ill.

MAKING CULVERT REPAIRS

The detour, one of the motorist's pet bugbears, may be avoided in a good many cases where it was formerly common to close the road to make a certain type of repairs.

This has reference to cases where small bridge or culvert installations are being made—either because of failure of existing structures or because additional drainage has been found necessary.

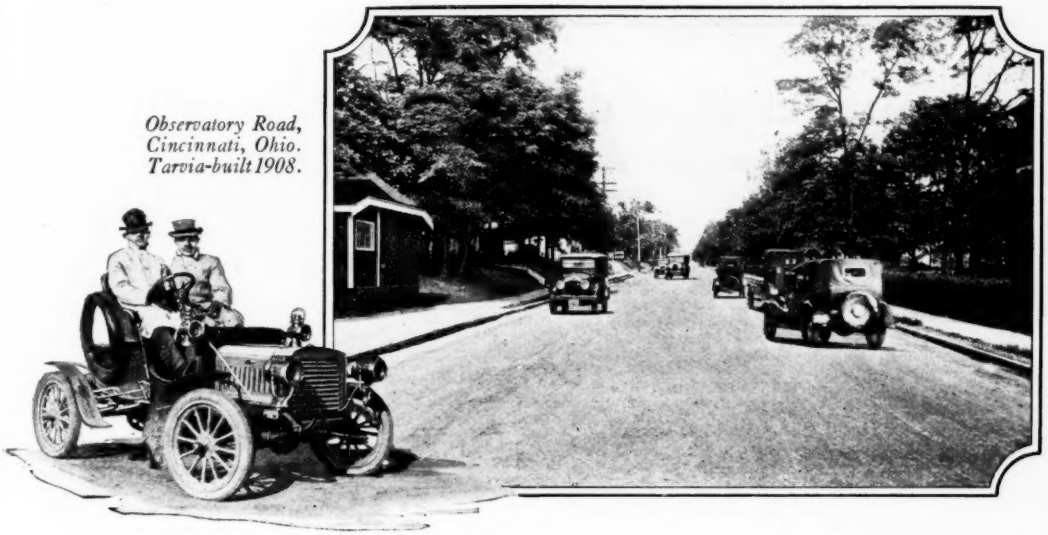
Instead of tearing up the roadway to replace failed culverts, highway engineers in many cases are now using sections of corrugated iron pipe which they simply slip inside the failed structure, and pour concrete or ram earth into the space between the pipe and the old culvert.

The result is a perfectly sound culvert, installed at far less cost than the previous structure and without any disturbance to traffic.

In cases where a new culvert is to be installed, instead of tearing up the road surface and digging a trench, the same long sections of corrugated pipe are jacked and tunneled into position without digging the usual trench. This operation is made easy because of the light weight and elasticity of the corrugated iron material.

Even small bridges made of one or more large sections of large-size corrugated iron pipe have been installed without detours, by installing and filling in one side at a time—an impossibility with most other types of materials.

Motorists, as well as highway officials, appreciate the advantages of these methods which obviate detours. The resulting structures have several advantages over heavy, rigid materials, and the estimated life of the corrugated pipe, when made of the purest commercial iron, is 50 years or more, according to H. P. Gillette.



Observatory Road, Cincinnati, Ohio. Tarvia-built 1908.

Traffic doubled and redoubled many times —but the Tarvia street is still good

IN 1908 they built the Tarvia pavement on Observatory Road. Motorists found it smooth —always free from mud and dust.

The old cars have gone their way—motor traffic has doubled and redoubled many times. But after sixteen years of this ever-increasing grind, Observatory Road's Tarvia pavement is still good.

Tarvia pavement can be kept good indefinitely at little cost. And in addition: A Tarvia pavement will not wave, roll or rut. A Tarvia pavement is skidproof, because of its granular surface.

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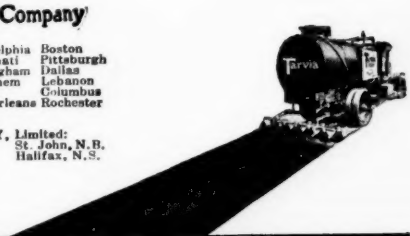
Baltimore	Syracuse	New Orleans	Rochester

In Canada:
THE BARRETT COMPANY, Limited:

Montreal	Toronto	St. John, N.B.
Winnipeg	Vancouver	Halifax, N.S.